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Study of the Effectiveness of State Motor Vehicle Inspection Programs

Final Report

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Executive Summary

The Conference Report on the Continuing Resolution for FY 1988 (P.L. 100-202) directed the National Highway Traffic Safety Administration (NHTSA) to conduct a comprehensive evaluation of the effectiveness of State motor vehicle safety inspection programs in (1) reducing highway crashes that result in injuries and deaths, and (2) limiting the number of defective or unsafe motor vehicles on the highways.

The evaluation was conducted by a NHTSA task force. This task force reviewed relevant literature, studied existing Periodic Motor Vehicle Inspection (PMVI) programs, conducted site visits to selected PMVI and non-PMVI States, and analyzed NHTSA's crash data bases. In addition, two public hearings were held and comments requested from the public through two separate notices published in the *Federal Register.*

Much of the prior research regarding PMVI programs predates 1980. Past studies on vehicle degradation point to the need for more sophisticated inspection equipment and procedures. At the same time, most of the literature concluded that reliability of the current PMVI process is generally poor. Nevertheless, there was a positive correlation between vehicle condition and the presence of an inspection program and "better maintained vehicles" have some potential for lower involvement in crash rates. However, there was no conclusive evidence in the literature that periodic motor vehicle inspection programs are, or are not, effective in reducing crashes.

Currently, 21 States and the District of Columbia have periodic motor vehicle inspection programs. Fourteen PMVI States and the District of Columbia, and 18 non-PMVI States inspect for emissions. In the PMVI jurisdictions, there is considerable variation in the equipment items inspected, and in the procedures, rules and regulations for inspections.

NHTSA analysis of the Fatal Accident Records System (FARS) data and State crash data files failed to show any evidence in the crash data examined which would suggest that PMVI programs affect the crash involvement rates of older vehicles compared to newer vehicles. The fatal crash involvement rate of older vehicles compared to new vehicles was not significantly different between PMVI and non-PMVI States. State data files in total crash involvement did not indicate a difference between the crash involvement rate by model year, PMVI compared to non-PMVI States.

In addition to the crash involvement rate analysis, data from the Crash Avoidance Research Data file (CARDfile) for four States were analyzed. The CARDfile data elements of interest in this analysis, i.e., vehicle component failures, are subjectively reported by the investigating police officer. Statistical tests of significance indicated that non-PMVI States reported a higher percentage of old and new crash-involved vehicles with component failures. Tire failures accounted for the majority of the increased percentage of component failures reported in the non-PMVI States.

As a result of the literature review, NHTSA's analysis of various data files, comments to the docket, and public hearings, the task force found that PMVI was effective in limiting the number of poorly maintained vehicles on the highways. Our attempts to correlate this with a reduction in crashes on the highways failed to show any significant effect of PMVI. The analyses of the FARS and State Crash data did not show crash reduction results benefits in PMVI States.

The CARDfile analysis did show benefits for PMVI in terms of vehicle component failures, but the benefits were so small (a maximum 1.5% reduction, for older vehicles) as to not have much practical significance. In a further analysis of FARS data, the contribution of vehicle component failures to crashes confirmed the findings in the CARDfile analysis.

From the comments to the docket and through testimony at the public hearings, most commenters expressed the desirability of receiving guidance from the Federal Government to help strengthen State PMVI programs. At the same time, the commenters said that PMVI should not be Federally mandated. There was no strong sentiment by the commenters for direct Federal funding support. The commenters favored combining safety and emissions inspections, as a logical and cost-effective approach, and one that would provide greater convenience to the motorist. The importance of technological improvements was stressed by the commenters, with the suggestion that Federal Motor Vehicle Safety Standards be reviewed and amended to include on-board diagnostic technology to improve the quality of inspections. The need was expressed for technological improvements of the inspection facilities to improve quality and to instill more confidence by the public on inspection results.

SECTION I

BACKGROUND

The Conference Report on the Continuing Resolution for FY 1988 (P.L. 100-202) directed NHTSA to conduct a comprehensive evaluation of the effectiveness of State motor vehicle safety inspection programs in (1) reducing highway crashes that result in injuries and deaths, and (2) limiting the number of defective or unsafe motor vehicles on the highways.

The evaluation was conducted by a NHTSA task force. This task force reviewed relevant literature, studied existing Periodic Motor Vehicle Inspection (PMVI) programs, analyzed NHTSA's crash data bases for evidence of effectiveness of these programs, and sought public participation through two public hearings and two *Federal Register* notices. NHTSA especially encouraged participation by State and local motor vehicle agencies, other public and private organizations, affected industries and consumer organizations, the automobile insurance industry, and experts in such fields as highway safety research, vehicle safety performance, inspection equipment and techniques, PMVI program administration, emissions inspections, and enforcement. The task force also conducted a series of site visits to both PMVI and non-PMVI States to review ongoing programs. A number of State officials were interviewed, in PMVI States on how inspection programs were managed; in non-PMVI States, reasons why no programs were in place; and in former PMVI States, why the inspection programs were eliminated or repealed.

Currently, safety oriented PMVI programs are conducted by 21 States and the District of Columbia. These programs affect about 68 million, or roughly 38%, of all registered vehicles in the United States.

Of the non-inspection States, some do provide for *spot* inspection, or other variations of inspection affecting certain classes of vehicles, such as school buses.

There are significant differences among the States that do have PMVI. These differences include the vehicle components that are inspected, the inspection procedures that are employed, the supervision of the process, and the enforcement activities. Some States have both safety PMVI programs and emission inspection programs. Other States have just one of the programs.

In those States with PMVI, all classes of vehicles registered in the States are subject to inspection. However, under the Motor Carrier Safety Act of 1984, the Federal Highway Administration (FHWA) has developed a rule for periodic motor vehicle inspection for commercial motor vehicles (53 FR 49402). Therefore, the task force focused only on those vehicles with a gross vehicle weight of less than 10,000 lbs.

Since the early 1970's, several attempts have been made to determine the effectiveness and cost-benefits of PMVI programs. In addition, attempts have been made to develop improved methods for inspecting vehicle subsystems as part of the PMVI process. The success of these efforts was varied or not consistent.

It has been shown that it is extremely difficult to assess the extent to which PMVI results in a better maintained vehicle fleet nationwide. This is because such an assessment must be made independently of the PMVI process, such as an extensive random vehicle inspection program. Because of sample size considerations, and their attendant cost implications, in-depth studies addressing this issue have not been done for several

years. For these same reasons, it was not possible to address this issue experimentally in this study. However, all previous work was reviewed and was used as the basis for the discussions in this area.

The safety benefits resulting from PMVI programs have also been difficult to establish because of the limited amount of information available concerning the role that component failures play in highway crashes. However, data sets have improved and more information is now available than in earlier efforts. NHTSA analysts used the most extensive crash data sets available in their attempts to establish correlations between component failures and vehicle crashes.

The issues involved in inspecting vehicle systems with the goal of predicting vehicle safety system failures are quite well-understood and the implications that these issues have on the PMVI process are documented. Existing inspection techniques do not provide inspectors with the ability to make meaningful predictions of when components may fail thus compounding the ability to determine the effectiveness of PMVI programs. In addition, the possibility of combining PMVI with emissions inspections was considered. Information relevant to this issue was solicited during the public hearings, in the *Federal Register* notice and during the site visits. The views of the Environmental Protection Agency (EPA) were also obtained.

A limited review of the latest technological developments in PMVI was conducted, as well as an assessment of future system needs.

SECTION II

SUMMARY OF THE LITERATURE REVIEW

In the task force's review of the literature, the most complete source of information was found in the January 1985 study by the University of Michigan Transportation Research Institute (Wolfe and O'Day). This was a NHTSA sponsored review of the PMVI literature, and presented the most comprehensive review of the pre-1984 literature available. Accordingly, much of the discussion on the literature is taken from this University of Michigan study. The sources for this review are listed in the Bibliography. Nearly all sources predate 1980. The task force also became aware of programs in Europe, Australia and New Zealand. A recent conference in Brussels (October, 1988) dealt with vehicle inspection, including developing technologies and methods, and computerization of inspection stations. However, the final proceedings have not been published and the task force was not able to obtain specific details on these foreign programs in time for inclusion in this report. There has been very little recent research or studies of PMVI in the United States, either on the effectiveness of ongoing programs, or on the latest technological developments. Except for limited developments in the foreign and private sectors, we found no evidence of any significant current research at the National or State levels. Neither did we find evidence of current research among associations or individuals concerned with PMVI in the United States.

A. National Guidelines and Procedures

The guidelines for State PMVI programs are those issued periodically by national organizations concerned with inspection. The American National Standards Institute, ANSI (United States of America Standards Institute) originally developed and issued voluntary inspection standards and procedures in 1941, with revisions in 1956, 1963, 1968, and 1973.

In 1968, NHTSA endorsed these standards and procedures as provided for by the NHTSA Highway Safety Program Guideline No. 1, Periodic Motor Vehicle Inspection. In 1973, NHTSA modified its endorsement with the issuance of its voluntary Vehicle-in-Use Inspection (VIU) Standards covering brakes, tires and wheels, and steering and suspension systems (See Appendix B). In addition, NHTSA encouraged the States to adopt the standards issued by ANSI that were not covered by the VIU Inspection Standards. NHTSA has not revised nor issued further PMVI materials for use by the States since the VIU Standards of 1973. As discussed in Section III, the States were originally required to comply with Federal Standards in order to receive Federal funding. This is no longer required, and the Standards have been changed to guidelines.

In 1978, the American Association of Motor Vehicle Administrators (AAMVA) issued Recommended Uniform Guidelines for the inspection of vehicle systems and components. These Guidelines are provided in Appendix C.

In recent years, the Motor Vehicle Manufacturers Association (MVMA), in cooperation with the AAMVA, has published Vehicle Inspection Handbooks for passenger vehicles, trucks, buses, and school buses covering brakes, tires and wheels, suspension and steering, lighting and electrical, glazing, body and sheetmetal, and fuel system and exhaust. The publications include an interpretation of the ANSI American National Standards Inspection Procedures for Motor Vehicles, Trailers and Semitrailers Operated on Public Highways (ANSI Stand-

ard D7.1) and the VIU Inspection Standards issued by NHTSA.

The MVMA Handbooks are updated on an annual basis and new testing procedures are defined when new vehicle technology is introduced. Recent updates, for example, contained discussions of the impact of aerodynamic headlights and anti-lock braking systems on inspection procedures.

B. State Inspection Programs

Effectiveness of Inspections in Improving Vehicle Condition: A number of past studies have compared the general condition of vehicles in PMVI jurisdictions and in non-PMVI jurisdictions, and the PMVI vehicles have generally come out ahead.

In 1968 McCutcheon and Sherman (1968) compared the condition of vehicles at inspections in Washington, D.C. (annual), Cincinnati (Semi-annual), and Memphis (tri-annual), with the results of State police inspections checklanes in non-PMVI Ann Arbor. Even though Ann Arbor is atypically high in average income and education, its vehicles had much higher defect rates. Vehicle failure rates on at least one of 18 categories were 93.7% in Ann Arbor, 42.6% in Washington, 34.1% in Cincinnati, and 12.4% in Memphis (14 categories only). This report not only provides evidence that PMVI leads to better-maintained vehicles than no inspection, but it also supports the thesis that the frequency of inspections is an important contributor to safer vehicles.

Two NHTSA-sponsored studies by Ultrasystems (Fisher *et al.*, 1971, 1973) also came to similar conclusions. The first compared the results for randomly selected and drop-in vehicles inspected at six diagnostic centers in California, a diagnostic center in Pennsylvania, a diagnostic center in New Jersey, and the two city inspection stations in Washington, D.C. For the common inspected components, Pennsylvania, with its semi-annual private-station system, had the lowest outage rate (5.93%), followed by Washington (7.44%) and New Jersey (8.93%), each of which have annual government-operated inspections, and by California (10.7%), which had a random police inspection system. The second study compared similar representative samples from four diagnostic centers in Illinois; from single diagnostic centers in Alabama, Arizona, Missouri, and Washington State; and from NHTSA's mobile inspection van in Hartford, Connecticut. Among these six States only Missouri had a PMVI program (annual at private stations), but it turned out to have the highest outage rates in the State comparisons. On the other hand, all six States had higher outage rates than did Pennsylvania, the District of Columbia, and New Jersey in the first study. The Missouri results suggest that there are significant differences in the quality of inspection programs in the various PMVI States. A re-analysis of the 1971 data by the Pennsylvania Office of Budget and Administration (1981) found that the differences between Pennsylvania and the other three jurisdictions were statistically significant, but they concluded that these differences were not large enough to have much practical effect on crash rates.

Another NHTSA-sponsored comparative study was carried out by Automated Sciences Group, Inc. (Hatch *et al.*, 1976), this time using a mobile inspection van set up in parking lots in five cities in each of six States: Pennsylvania, Missouri, California, Illinois, and two new States, Texas and Maryland. Texas has long had an annual private-station PMVI system, while Maryland requires a

fairly extensive inspection at the time a vehicle changes ownership. In the Maryland sample 37.5% of the inspected vehicles had previously been inspected. In this study, participation in the inspections was entirely on a voluntary drop-in basis, so the representativeness of the State samples is open to question. (In such research studies, there is concern that volunteers may be more conscious of highway safety and consequently, have better maintained vehicles than the total population of vehicles they are intended to represent). In the analysis, regression techniques were used to control for 20 possible explanatory variables, such as vehicle age and owner income. In comparing outage rates on 34 components which were supposed to be inspected in some States, 16 components had significantly lower outage rates in States in which they were part of the inspection program. On the other hand, there were six components in which the outage rates were significantly lower in the non-inspection States.

A multi-State study was carried out in connection with NHTSA's diagnostic inspection demonstration program in Alabama, Arizona, Puerto Rico, Tennessee, and Washington, D.C. (Innes and Eder, 1977). Again participants were volunteers, so the representatives of the samples is open to question. Nevertheless, the dramatic differences found between the vehicles in non-PMVI Alabama and Arizona (93.2% and 91.9% failure rates) and the vehicles in the PMVI jurisdictions Chattanooga and Washington (47.4% and 48.0% failure rates) again support the potential value of PMVI in improving vehicle condition. However, PMVI Puerto Rico had a failure rate of 90.4%, again demonstrating that there are substantial differences in the effectiveness of different PMVI programs.

Among the eleven State trial substitute inspection programs summarized by Eder *et al.* (1978), two provided a direct comparison of vehicle condition in PMVI and non-PMVI jurisdictions. In the 1970's those States without PMVI were encouraged to study alternate methods of safety inspections comparing these to a regular PMVI program. In Ohio only 11.35% of the vehicles in the Cincinnati PMVI station were defective, while 35.19% of the vehicles inspected randomly by the police in the rest of Ohio were defective. In Tennessee results from the regular inspection station in PMVI Memphis and from the free diagnostic inspection station in PMVI Chattanooga showed that the vehicles in those PMVI cities were in better condition than vehicles tested at a special inspection station in non-PMVI Knoxville. Also the California Highway Patrol (1974) reported that its experiment with different levels of inspection effort found that the vehicles in counties with higher levels of random inspection tended to be in better condition than vehicles in the counties with low or no inspection levels.

NHTSA (Eder 1980) also sponsored a before-after study of vehicle condition in Idaho after it discontinued its State inspection program in 1976. A mobile inspection van was used at the same parking lot locations in the fall of 1976 and again in the fall of 1978, and the participating vehicles were voluntarily recruited on a drop-in basis. The results were that brakes, steering, suspension, and power train components were somewhat worse in 1978 than in 1976, while body components (lights, etc.) were about the same. This was true even though the 1978 sample was somewhat older than the 1976 sample (average of 5.4 years compared to an average of 4.7 years). This study in one State provides evidence that PMVI can induce some improvements in the safety condition

of a State's vehicles, or at least that discontinuing PMVI has a somewhat negative effect on the condition of a State's vehicles.

Reliability of Inspection Programs: There is considerable evidence that PMVI programs are far from being as effective in improving vehicle safety conditions as would be desirable. A Carnegie-Mellon University study (1975) involved having the same vehicle with 13 implanted defects inspected at 20 private stations in Pittsburgh. All of the defects were on the list of inspection items of Pennsylvania. The number of defects found ranged from one to seven with an average of 3.96. In addition, the number of non-existent defects reported ranged from none to seven with an average of 1.75. These Pittsburgh inspection stations might not be typical of the rest of the State, but the Carnegie-Mellon study also looked at 6,000 inspection forms from various inspection stations all over the State, and they found a great variation in rejection rates among different inspection stations. Such findings concerning inspection effectiveness may help to explain why Hatch *et al.* found vehicles in no-inspection Illinois in better condition than Pennsylvania vehicles on some components.

Similar inspection station problems were found in the AVCO study (Bentley and Heldt 1977) in Missouri and in the Chilton study (Milne *et al.*, 1978) in New Hampshire and Virginia. In evaluating compliance with the State requirements for inspection facilities, equipment, and procedures at 90 stations in New Hampshire and 85 stations in Virginia, overall compliance rates were determined as 94.0% in Virginia and only 78.4% in New Hampshire. In regard to mechanic knowledge of State standards (e.g., minimum brakeshoe lining thickness), only 45.9% in Virginia and 24.4% in New Hampshire were able to answer three out of five questions correctly. Covert inspections were also made of the inspection process at 30 stations in each State, using 14 inspection items in Virginia and 15 items in New Hampshire. The overall compliance rates were 78.6% in Virginia and 57.4% in New Hampshire. Eight of the 30 stations in New Hampshire and six of the 30 stations in Virginia did not carry out the required wheel pull to check the brakes. Not one station in New Hampshire failed the two obviously defective tires. In Missouri Bentley and Heldt estimated the Statewide administrative compliance rate as 87.3%, while the covert inspections provided a compliance rate of 77.4%. So Missouri seemed to be somewhere between Virginia and New Hampshire in the operational conduct of its PMVI program.

The diagnostic inspection demonstration program (Innes and Eder, 1977) also provided some useful information on problems in the vehicle repair industry which relate to the quality of repairs available for components found to be defective at an inspection. In this program, the inspections were free and presumably of high quality. However, motorists found to have defective components had to go elsewhere to obtain repairs. If they obtained repairs they could return for a free reinspection. Overall 27.2% of the returnees after their first inspection failed their reinspection. However, the reinspection failure rates varied greatly: from only 2% in Washington, 10% in Tennessee, to 14% in Puerto Rico, to 33% in Arizona, to 50% in Alabama. A special study in Alabama (Schroer and Peters, 1977) showed that 23% of the repairs involving 32% of the repair costs were considered unnecessary by the diagnostic team. These were repairs to components which had not failed the first inspection and which were not

recommended, or optional repairs in conjunction with the repair of a failed component.

Thus, while the evidence of past studies suggests that vehicle safety condition is at least somewhat better on the average in some PMVI States and cities than in non-PMVI States, it also suggests that this is not true for all PMVI areas or for all safety-critical components. Many areas which have PMVI do not require inspection of all important safety components, and many licensed inspection stations do not conduct proper inspections of all the components they are required by law to inspect. In addition, there is evidence that frequently, repairs of inspected components which are found to be defective, are not properly made. It has been suggested that a major reason for the frequent poor quality of inspections is the reluctance of State legislatures to set realistic maximum inspection fees. For example, the New York Department of Motor Vehicles (1982) estimated that a proper inspection should take about 30 minutes. Yet in New York the inspection fee is $8. These low inspection fees may discourage the hiring of highly qualified inspection mechanics and encourage the finding of items which need to be repaired so that the station can try to recover its full inspection costs. The Pennsylvania Office of Budget and Administration (1981) estimated that a complete inspection according to Pennsylvania guidelines would take over an hour, and it recommended a reduction in the items to be inspected.

Possibly, some of the problems in inspection reliability might be the lack of adequate or sophisticated enough equipment and procedures, together with a limited number of items being inspected. There have been several studies in the late 1960's and early 1970's on vehicle component degradation and inspection techniques. In 1977, Systems Technology, Inc. developed measures for investigating the influence of vehicles-in-use steering, suspension and brake system degradation on vehicle handling. Results showed that front end alignment and ball joints have little influence on vehicle handling unless extreme degradation is involved. Brake imbalance, front suspension bushing free play, low fluid shocks (rear), and steer free play affect vehicle handling, and have pronounced influence when occurring in combination. A Clayton Manufacturing Company Study (1969) concluded that loose ball joints, weak shock absorbers, poor alignment and brake imbalance should be included in inspection programs. In a TRW System Group report (1969), it was recommended that dynamic road testing should be performed at speeds above 40 miles per hour, dynamic and visual testing of brakes should be a part of any inspection system, and a dynamic brake analyzer for brake inspection should be developed.

A Bendix Corporation Study in 1972 (Keramen, Ducharme, and Matle) recommended that brake inspection equipment measure pedal force, front to rear brake balance, side-to-side balance and brake fade. Further, brake inspection should include a visual inspection to check for leaky wheel cylinders and brake system integrity. Finally, a 1971 Cornell Aeronautical Laboratory, Inc. Study (Bird, Belsdorf, and Rice) recommended that shock absorbers be inspected visually, ball joint condition and steering free play should be a part of an inspection program and criteria be developed for inspection of front-end misalignment.

As discussed in Section III, there is a wide variance in the equipment items inspected, as well as the degree of inspection for each.

Changes in Vehicle Component Related Crashes with PMVI: The tri-level study of crash causation carried out by Indiana University's Institute for Research in Public Safety (Treat and Stansifer, 1977) is frequently referred to in the inspection literature as a key source of information on the role of vehicle defects in causing crashes. Preliminary data from this seminal in-depth study of crashes in Monroe County, Indiana, had indicated that 6.0% of crashes were definitely caused, and a further 9.9% were probably caused, by vehicle defects (NHTSA 1975). However, the final report reduced these figures somewhat (Treat and Stansifer 1977). It concluded that vehicle defects were definitely causal or severity-increasing in 4.5%, probably causal or severity-increasing (at least 80% probability) in a further 8.1% and possibly causal or severity-increasing (at least 25% probability) in a further 12.6% of the 420 crashes studied in-depth. The results of the Indiana study (usually the preliminary results) were cited by many of the publications included in this review, but only one mentioned the fact that these vehicle defects were seldom the sole cause of the crashes. In both the in-depth and the 2,558 less thorough on-site crash investigations, only 2.4% of the crashes were judged to have been definitely or probably caused **only** by vehicle defects.

The most frequent certain, probable, or possible causal defects (8.8% in the in-depth study) involved worn and/or underinflated tires, defects which are difficult to improve very much in a once-a-year inspection. The second most frequent causal defects (7.6% in the in-depth study) were brake problems such as gross failure, side-to-side imbalance, and delay. Looking just at **certain** causal factors, brake problems were cited in 2.9% of the in-depth cases, while tire and wheel problems were cited in 0.5% of these cases. Yet only a few States include a wheel pull to check brake linings as part of their PMVI procedures. Treat and Stansifer (1977) report that these findings agree with a similar on-site study in Great Britain and with other smaller studies in the United States. It has been argued that the Indiana tri-level study is outdated, making results invalid for today's vehicles. This is essentially due to vehicle component improvements over the past years, especially in braking systems.

In addition to these special crash investigation studies, many police agencies record observed vehicle defects on their accident report forms. However, surprisingly few references to these data were found in the literature review. NHTSA (1975) did cite data from Texas which showed a decline from 12% in 1951 to 4% in 1971 in defective vehicle involvement in crashes. Also cited were data from Nebraska which showed a decline from 6.1% in 1968 to 2.6% in 1972 in defective vehicle involvement in rural crashes following the implementation of a PMVI program. In addition, Eder *et al.* (1978) reported that 1975 Ohio crash data showed vehicle defects in 1.3% of the crash involved vehicles in PMVI Cincinnati, compared to 1.8% in random inspections in the rest of the State. These figures are much smaller than the 17% defect-related crashes found in Ohio Turnpike crash data for 1966-1970 (O'Day and Carlson 1973). The comparable figures reported for the Indiana Turnpike and for the Pennsylvania Turnpike were 12% and 7% respectively. They reported a 3% defective vehicle rate for 1970 Texas crashes.

The Pennsylvania Office of Budget and Administration (1981) reported that for 1974 to 1976 the proportions of crashes in which vehicle-related factors were considered by the police to be the primary cause varied

from 0.8% to 1.8% for fatal crashes, from 2.5% to 3.0% for injury crashes, and from 1.9% to 2.5% for property damage only crashes. The Carnegie-Mellon study (1975) reported that about 2.5% of police-reported crashes in Pennsylvania involved vehicle defects.

In an attempt to determine the validity of police reported involvement of vehicle component failures in crashes, the Indiana tri-level study compared the police report of vehicle defects with their in-depth findings in 124 crash cases. The investigating team found far more defects than the police did, but most of them were not considered contributing factors in the crashes. In the six cases in which the police had cited defective brakes as a contributing factor, the team agreed on four cases but judged that defective brakes were not a causal factor in the other two cases. Also the team cited defective brakes as causal factors in three other cases in which the police had not mentioned them. The police accident form did not provide for checking tire problems, so this problem was ignored by the police reports, while it was considered at least possibly causal in seven crashes investigated by the special team. While this study was limited in scope, it supports the hypothesis that police accident reports are likely to both under-report and incorrectly report vehicle defects as contributing factors in crashes.

On the other hand, a study of vehicle-related crashes in 1976 Fatal Accident Reporting System (FARS) data (O'Day *et al.*, 1978) suggests that there may be over-reporting of vehicle defects in some police-reported crashes. In eight States the defect rates reported as contributing to the fatal crashes varied from 1.3% in Michigan to 9.9% in Ohio to 12.9% in Connecticut. A review of some of the hard-copy records in Ohio and Michigan showed that the Ohio accident report form had a special place to indicate vehicle defects separately from crash causation information; yet this vehicle defect information was always coded as a contributing factor in the crash in the Ohio FARS data. Thus, defective tires were shown as contributing to the crash 177 times in Ohio and only 12 times in Michigan where defects were only indicated in a single contributing circumstances section of the form (with two mentions possible).

The type of police reporting forms and the reporting procedures appear to have a great deal to do with the types of data on vehicle defects available in State crash files. Thus, without additional information, it is difficult to tell whether the changes in vehicle-related crashes reported in Texas and Nebraska reflect genuine reduction in vehicle defects, or whether they may be largely accounted for by changes in police report forms or procedures.

Reductions in Crashes from PMVI: In addition to the previously cited studies of crashes involving failed components, there have been a number of studies which have looked at fatal, injury and total crashes in relation to PMVI. The most notable of these was the recent time-series analysis of crashes carried out by the New Jersey Institute of Technology (NJIT). Jackson *et al.* (1982) looked at New Jersey crash data back to 1929, and found a rapidly rising crash rate in the 1930's and then a large drop in 1938, the year New Jersey instituted a semi-annual inspection program. Trying models with various combinations of 13 independent variables, such as year, population, income, registered vehicles, drunk driving arrests, PMVI or not, and war years or not, they concluded that PMVI was associated with an average annual saving of 314 lives and an annual average

reduction of 37,949 crashes since 1938 in the State of New Jersey. [These numbers were later revised to 304 lives saved and 37,910 crashes avoided in Loeb and Gilad (1984)]. None of the tested models found a significant reduction in injuries. The estimate of 304-314 lives saved per year due to PMVI seems unrealistic, considering that in the late 1970's New Jersey had only about 1,100 fatalities per year. Also the lack of a concomitant reduction in injuries suggests that the models used in the time-series analyses were not adequate to cover all the important changes affecting crash rates over the 51 years analyzed (e.g., improvements in emergency medical services, 55 mile per hour speed limit etc.). While the regression analysis seems quite sophisticated, the use of year as a surrogate for all technological and other relevant changes over time is inadequate, and the fact that there are only nine points in the baseline period may partially account for the large fatality reductions found. There must be some other important variables which co-vary with inspection to show such a large impact, and it is unreasonable to propose that vehicle inspection in New Jersey is currently saving 314 (or 304) lives per year. The same types of models have not been replicated in other inspection and non-inspection States.

This was the only study found which looked at general crash trends in relation to PMVI within a single State. However, a number of studies have made such comparisons among States. In 1963 Mayer and Hoult reported that States with a State-operated PMVI system had lower death rates in relation to miles traveled than did States with other inspection systems which in turn had lower death rates than States with no inspection systems during the period 1948-1959. In 1966 Buxbaum and Colton also reported results favorable to PMVI in an analysis of 1960 death rates of men aged 45-54. In this analysis they controlled separately on four independent factors: region, population, registered vehicles, and average gasoline consumption.

Another study was Little's (1968, 1971) comparing death rates in six States which had introduced PMVI between 1951 and 1961 with six matching States which already had PMVI, and with six matching States which never had PMVI. For each PMVI State he used crash data for the six years before and six years after beginning PMVI. In this single-factor analysis he found a 10.2% **increase** in the fatality rates in the six test States (those States which had introduced PMVI between 1951 and 1961), a 4.8% increase in the six PMVI control States, a 4.6% increase in the six non-PMVI control States, and a 1.9% increase for the whole United States. He concluded that fatal crash rates are not a good measure for evaluating the effectiveness of PMVI programs.

In 1976 Wort, in testimony before the Illinois Motor Vehicle Laws Commission, presented a comparison of traffic death rates in States with and without PMVI from 1949 to 1973. He found that the trends had changed in 1968 to favor the non-PMVI States for the last five years of his series.

The Pennsylvania Office of Budget and Administration (1981) carried out a regression analysis of 1971-1973 State fatality and injury crash data using up to 17 demographic, socioeconomic, environmental, and highway factors as independent variables. They were able to explain up to 8.2% of the variance in fatality rates and up to 42% of the variance in combined fatality and injury crash rates. However, they did not find significant differences between PMVI and non-PMVI

States when controlling on the other important factors.

The Carnegie-Mellon study (1975) looked at 1974 crash rates among the States, and it found that random-inspection States had the lowest fatality rates in relation to miles traveled, followed by States with semi-annual PMVI, States with annual PMVI, and States with no inspection programs. The authors also attempted a regression analysis with up to 19 independent variables, but no model was able to explain more than 55% of the variations in State crash rates. They suggested that a satisfactory model should explain at least 90% of the variance, since vehicle defects cause such a small proportion of crashes.

There is also one study in the literature which compares crash rates in a single area in relation to whether vehicles had been inspected or not (Schroer and Peyton, 1977). This was in Huntsville, Alabama, in connection with the Federally funded diagnostic inspection demonstration project there. The authors found a 9.1% to 21.1% lower crash rate among the inspected vehicles, compared to the uninspected vehicles in the same city. Unfortunately, due to the voluntary nature of participation in the Huntsville inspection program, it is difficult to determine the significance of these. Schroer and Peyton (1977) also reported at least a 5.3% reduction in crashes for the inspected vehicles in the period after the diagnostic inspection compared to the period before the inspection. In New Brunswick, Wilson (1973) reported that 1970-1971 crash rates were significantly lower in areas where the rejection rates at the annual inspection were lower, presumably indicating that the vehicles in those areas were generally in safer condition and thus less crash-involved.

There were also two studies which attempted to relate crash involvement (not just vehicle-defect crashes) to time since inspection. In Virginia, Garrett and Tharp (1969) were not able to find any relationship between time since inspection and crash involvement. Similarly, Reinfurt and Symons (1974) found no significant relationship between the introduction of PMVI and crashes or between time since inspection and crashes in North Carolina and Florida. However, in Virginia the number of crashes studied was rather small, and in Florida the inspection follow-up period was quite short for seeking a significant relationship in crash data, while in North Carolina the data on date of inspection turned out to be unsatisfactory. Symons and Reinfurt (1975) presented some important statistical considerations for such time studies, including the large numbers of inspected vehicles crashes which must be analyzed in order to find a statistically significant relationship.

Given the evidence from the Indiana tri-level study that vehicle defects were definitely or probably the sole cause in only 2.4% of the crashes studied, given the many other factors related to crash rates, and given the evidence of rather substantial differences in the effectiveness of various State PMVI programs, the authors reported that it may not always be possible to expect to find definite relationships between general crash experience and the presence or absence of PMVI programs.

It should be noted that in connection with the Department of Transportation's *Highway Safety Needs Report* (1976), a panel of 103 experts (including 40 Governor's Representatives for Highway Safety) was surveyed regarding their perceptions of the effectiveness of various countermeasures in reducing the frequency and severity of traffic crashes.

Among 43 countermeasures which were rated, current PMVI procedures were ranked 40th, while new PMVI procedures focusing on safety critical components were ranked 34th. The consensus of experts in the field was that PMVI was not a highly effective safety program. Also, as discussed in Section III of this report, only one comment was received favoring PMVI as a priority area for Federal funding.

Cost-Effectiveness of PMVI: The first discussion of the cost-effectiveness of PMVI programs was found in a NHTSA report by the Office of State Vehicle Programs (1975). Using a 1972 study on the societal costs of motor vehicle crashes, preliminary Indiana tri-level data on vehicle-related crashes, and estimates of inspection costs of $2.42 for a minimum inspection (10 minutes) and $6.12 for a maximum inspection (24 minutes--with wheel pull), this study estimated that a minimum-inspection PMVI would have to be 6% to 15% effective in reducing vehicle-related crashes to be cost-effective, and a maximum-inspection PMVI would have to be 14% to 39% effective in reducing vehicle-related crashes to be cost-effective. However, the inspection cost figures do not include motorist's travel and time costs nor the costs of expedited or unnecessary repairs.

In 1977 the Government Accounting Office reviewed the studies of PMVI, and the Comptroller General made a report to Congress. It concluded that, while there was evidence that vehicle defects cause some crashes, there was no conclusive evidence that PMVI programs were cost-effective in reducing such crashes.

The Carnegie-Mellon study (1975) attempted to assess the cost-effectiveness of PMVI in Pennsylvania, using both actual inspection costs and an estimate of motorist's time and driving costs. While police crash data showed mechanical failures as contributing factors in only about 2.5% of Pennsylvania crashes, it used the preliminary Indiana tri-level data as a more realistic estimate of vehicle-related crashes. It estimated that, if in the absence of PMVI, 15.9% of Pennsylvania crashes would have been caused by vehicle defects, and if PMVI in Pennsylvania was 46% effective in reducing such vehicle-related crashes, then Pennsylvania's semi-annual PMVI system was cost-effective. The authors suggested that the Pennsylvania system could be made more cost-effective by increasing State monitoring activities, by changing to annual inspection, and by not inspecting vehicles less than two years old.

The NJIT report (Jackson *et al.*, 1982) also looked at the cost-effectiveness of PMVI in New Jersey. Using three different sets of estimates of the costs of motor vehicle crashes, actual data on the costs of inspections in New Jersey, estimates of motorist driving and time costs and of expedited repair costs, and the results of the regression analyses for reductions in fatalities, injuries, and crashes, a benefit cost ratio of at least 1.86 was found. In their later article Loeb and Gilad (1984) dropped a reduction in injuries as part of the benefit estimates, but they still projected 1.24:1 as a reasonable benefit-to-cost ratio for PMVI in New Jersey. Unnecessary repairs were not taken into account, and the validity of the great reductions in fatalities and crashes shown in the regression analysis is essential to these conclusions supporting the cost effectiveness of PMVI in New Jersey.

A cost-effectiveness analysis by Wort (1976) used 6% as the proportion of vehicle-related crashes, 10% as the estimated effectiveness of PMVI in reducing such crashes and $20 as

the average total inspection cost. He concluded that PMVI in Illinois would cost 20 times its benefits in reduced crashes.

Similarly, a California Highway Patrol discussion of cost-effectiveness (1974) compared mandatory inspection at inspection stations, random roadside inspection, and selective roadside inspection. Using preliminary data from the Indiana study of crash causation and making various assumptions about inspection effectiveness and costs, the authors found any random inspection system more effective than a mandatory system and they found that the lower the inspection rate the more cost-effective the inspection program. Pointing out that the oldest 50% of the vehicle population has 75% of the vehicle defects, the report concluded that a selective roadside inspection program concentrating on vehicles over four years old seemed to be the most cost-effective approach.

Abbene (1978) reviewed the literature in an attempt to determine if semi-annual PMVI in Virginia was cost-effective. Based on NHTSA multi-state studies which included semi-annual PMVI Pennsylvania, he estimated that semi-annual PMVI is 20-25% more effective than annual PMVI in improving vehicle condition. Using three possible estimates of defect-related crashes and two sets of crash cost estimates, he came up with various needed rates of effectiveness in reducing defect-related crashes in order for Virginia's program to be cost-effective. He concluded that the Virginia semi-annual program might be cost-effective, and suggested that annual programs would be more likely to be cost-effective (Virginia has since instituted an annual system). However, his benefit figures appear to be inflated because he multiplied all injury crashes in Virginia by the estimated cost of a disabling injury crash; ($5,000 and $7,500); and also his owner cost figures may be low ($4 for the inspection and $1 for cost of motorist's time).

Thompson (1982), in his discussion of the entire PMVI issue, attempted to estimate the cost-effectiveness of a nationwide, comprehensive, semi-annual PMVI system with a reliability of 90%. He assumed that such a program could reduce **total** crashes compared to a no-inspection program by 10%, thus saving $60 to $100 per vehicle per year, and he estimated that the average cost for two inspections per vehicle would be $78, including driving and time costs and the costs of making repairs earlier than in a no-inspection system. These estimates provided cost-benefit ratios on both sides of the cost-effectiveness question. He suggested that eliminating inspection of vehicles less than three years old and varying the inspection periods on other vehicles in relation to their condition at the time of inspection could lead to an optimal PMVI system which was clearly cost-effective. However, his assumption of a 10% reduction in **all** crashes from a reliable PMVI program seems high, based on other research. How he determined that traffic crashes cost $600 to $1000 per year per vehicle (which would amount to $96,000,000,000 to $160,000,000,000 annually for about 160,000,000 registered vehicles) is not discussed.

Summary and Conclusions: Most studies regarding the effectiveness of inspections in improving vehicle condition have found a correlation between improved vehicle condition and the presence of an inspection program. In the majority of these studies, PMVI jurisdictions were observed to have vehicles in somewhat better condition than non-PMVI jurisdictions. While the methodologies employed in most of these studies can be questioned, it seems reasonable to conclude that vehicle condi-

tion is frequently but not always better in jurisdictions with periodic inspection programs.

Past studies on vehicle degradation point to the need for more sophisticated inspection equipment and procedures. At the same time most of the literature conclude that reliability or effectiveness of the current PMVI process is generally poor. The principle reasons for this conclusion are: (1) the low probability of detecting defects when present, (2) the low likelihood requiring a defect to be repaired properly and at reasonable costs, and (3) the likelihood of the PMVI process being used to initiate unnecessary repairs.

In assessing changes in vehicle component related crashes with PMVI, given the rather small proportion of vehicle-defect crashes found in crash investigations, previous researchers questioned the ability to evaluate PMVI effectiveness by looking at vehicle-defect crash rates. In the tri-level study of crash causation in Indiana, the authors found vehicle defects to be definitely causal in about 4.5% of crashes, probably causal in a further 8.1%, and possibly causal in a further 12.6% of the 420 crashes studied in-depth. However, of the crashes studied, approximately 3000 in all, 2.4% were judged to be caused only by vehicle defects.

There have been a number of studies which have looked at fatal, injury and total crashes. However, these are generally inconclusive and unreliable, either due to the lack of credible data, or due to weaknesses in the study design. Moreover, while some studies have shown some crash reduction benefit from PMVI, others have indicated no effect of PMVI and in some instances, have shown a negative effect.

The literature includes various studies both supporting PMVI as a cost-effective program, while others conclude that it is not cost-effective. Essentially, all of the literature which supports PMVI as having safety benefits greater than the cost is based on correlation or regression studies from which causal inferences must be drawn with caution, plus they include questionable benefit estimates and incomplete cost estimates. None of the reviewed studies provided credible evidence that current PMVI programs were cost-effective on a cost "safety benefit" basis. This is mainly because there is a shortage of convincing research on the effectiveness of PMVI in reducing vehicle-defect related crashes.

In conclusion there is little question that periodic inspection can lead to somewhat improved vehicle condition, and that *better maintained vehicles* have some potential for lower involvement in crashes. But, there is no conclusive evidence in the literature that periodic motor vehicle inspection programs are effective in reducing crashes.

SECTION III

CURRENT STATUS OF STATE MOTOR VEHICLE INSPECTION PROGRAMS

NHTSA technical staff analyzed available documentation on PMVI programs in the States. This review was supplemented by a series of site visits to selected States for a more indepth review. In PMVI States, officials responsible for PMVI were interviewed regarding their implementation practices, experience and general management controls. At the same time, in both PMVI and non-PMVI States, information was obtained on why PMVI was accepted or rejected and the reasons for retention or repeal.

The States visited were the PMVI States of New Jersey, Pennsylvania, Virginia and Utah; and the non-PMVI States of Maryland, Georgia, Florida and Colorado. Additionally, comments made during the public hearings in response to the *Federal Register* notice provided further information on current status of PMVI programs. While the current status of State programs is addressed, this section also addresses the past and present Federal role in support of State PMVI programs and the factors for State acceptance and non-acceptance of PMVI. These two areas are intended to provide additional insight into how and why State programs are where they are today.

A. Overview of State Programs

Exhibit III-1 depicts the PMVI and non-PMVI States in the country as of June 30, 1989. Generally, the States that have mandatory PMVI programs are located in the east and parts of the south and southwest. Utah is the only State in the far west to have such a program.

Nineteen non-PMVI States reported that they conduct spot inspection of passenger vehicles, which consists of selecting vehicles from the traffic flow, and then carrying out an inspection on the side of the road. These States are shown in Exhibit III-2, together with a listing of those States with and without passenger car periodic inspection.

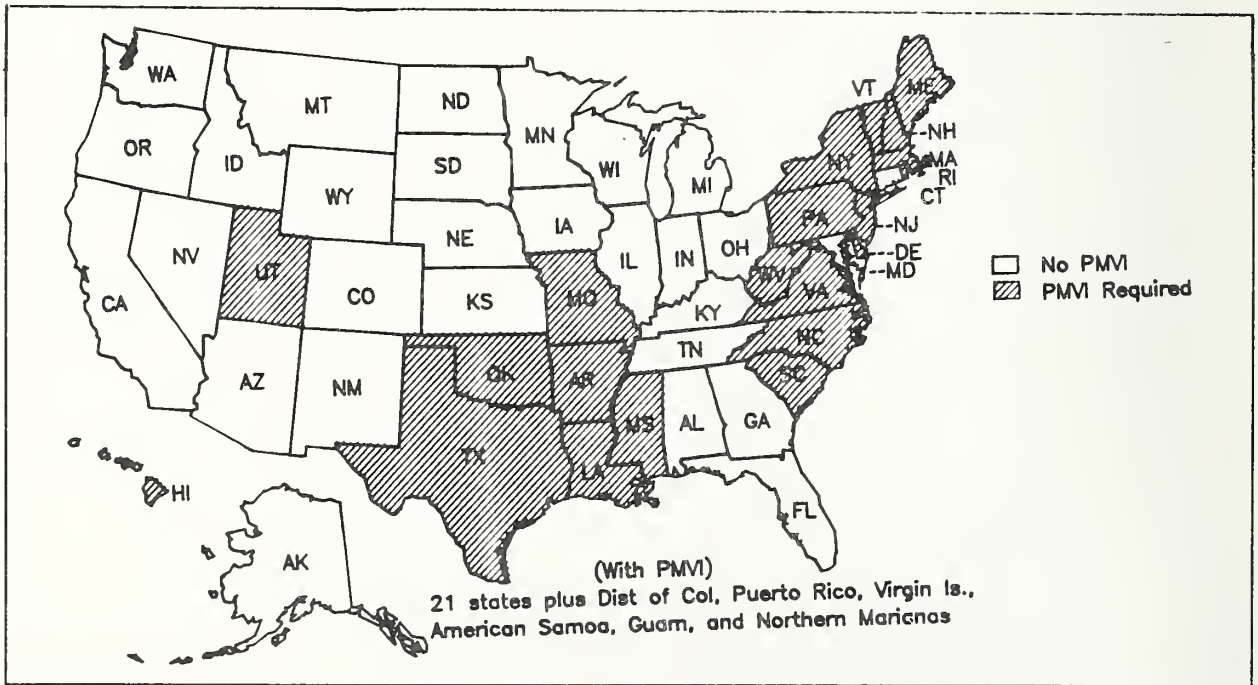

Exhibit III - 1 **National Status of Periodic Motor Vehicle Inspection Programs as of June 30, 1989**

None	Periodic	Random
Arizona	Arkansas	Alabama
California	Delaware	Alaska
Connecticut	District of Columbia	Colorado
Idaho	Hawaii	Florida
Illinois	Lousiana	Georgia
Indiana	Maine	Iowa
Nebraska	Massachusetts	Kansas
Nevada	Mississippi	Kentucky
Wyoming	Missouri	Maryland
Tennessee	New Jersey	Michigan
	New Hampshire	Minnesota
	New York	Montana
	North Carolina	New Mexico
	Oklahoma	North Dakota
	Pennsylvania	Ohio
	Rhode Island	Oregon
	South Carolina	South Dakota
	Texas	Washington
	Utah	Wisconsin
	Vermont	
	Virginia	
	West Virginia	
Totals :		
10	**21 + D.C.**	**19**

Exhibit III - 2 **Summary of State PMVI Programs as of December 31, 1988 (Passenger Vehicles)**

Exhibit III-3 lists each PMVI State, the dates each of their programs were started, the State department administering each program, the frequency of inspection and the inspection fee. All 21 PMVI States and the District of Columbia have annual inspections, and the inspection fee averages $6.40 per inspection. About one-half of the States administer their PMVI programs through their Department of Motor Vehicles, and about one-half administer them through the Highway Patrol or the State Police. Most of these latter States started their programs before the enactment of the Highway Safety Act of 1966.

Exhibit III-4 lists the States that have repealed their PMVI laws since 1976 and the year of the repeal. Most of these States enacted their PMVI laws after passage of the Highway Safety Act of 1966, which required PMVI as part of a comprehensive highway safety program.

Both PMVI and non-PMVI States also carry out spot inspection programs for commer-

State	Law Enacted	Program Started	Responsible Department	Frequency	Inspection Fee
Arkansas	1967	1969	Transportation Safety	Annual	$3.25
Delaware	1933	1933	Motor Vehicles	Annual	[1]
District of Columbia	1938	1939	Public Works	Annual	$5.00
Hawaii	1967	[2]	Transportation	Annual	$4.25-9.75
Louisiana	1960	1961	Public Safety & Motor Vehicles	Annual	$6.50
Maine	1930	1930	State Police	Annual	$5.00
Massachusetts	1926	1930	Motor Vehicles	Annual	$15.00
Mississippi	1960	1961	Public Safety	Annual	$5.00
Missouri	1967	1969	Highway Patrol	Annual	$4.50
New Hampshire	1930	1931	Safety	Annual	$8.00-12.00
New Jersey	1936	1938	Motor Vehicles	Annual	[1]
New York	1954	1957	Motor Vehicles	Annual	$8.00
North Carolina	1965	1966	Motor Vehicles	Annual	$5.05
Oklahoma	1967	1969	Public Safety	Annual[3]	$5.00
Pennsylvania	1927	1929	Transportation	Annual	Set by station
Rhode Island	1958	1959	Transportation	Annual	$4.00
South Carolina	1967	1968	Public Transportation	Annual	$3.00
Texas	1951	1951	Public Safety	Annual	$5.75
Utah	1936	1936	Highway Patrol	Annual	$10.00
Vermont	1935	1936	Motor Vehicles	Annual	Set by station
Virginia	1932	1921	State Police	Annual	$6.00
West Virginia	1953	1955	Public Safety & Motor Vehicles	Annual	$7.00

Notes:

[1] Fee is included in the registration fee.

[2] Before 1967, all four counties of Hawaii required periodic inspection under separate county ordinances or regulations. A State law was passed in 1967 centralizing the administration of the program with the counties conducting the inspection.

[3] Also, vehicles inspected prior to sale.

Exhibit III - 3 **Summary of Program Information of PMVI States as of June 30, 1988 (Passenger Vehicles)**

cial motor vehicles. As members of the Commercial Vehicle Safety Alliance, forty-seven States carry out common inspection procedures to increase the number of on-highway inspections by concentrating on equipment items found to be most involved in mechanical failure crashes, and to improve the safety of equipment being operated on the highways. Under this arrangement, States agree that inspections done in one State are honored for 90 days in all other member States.

This program and type of inspection are in harmony with the Motor Carrier Safety Assistance Program which is administered by the Federal Highway Administration (FHWA). This on-going cooperative endeavor between the Federal Government and States enforces uniform Federal and State safety and hazardous materials regula-

States	Year Repealed
Colorado[1]	1981
Florida	1981
Georgia	1982
Idaho	1976
Indiana	1980
Kentucky	1978
Montana[2]	1976
Nebraska	1982
New Mexico	1977
South Dakota	1979
Wyoming	1977

Notes:
[1] Law called for reinstating program unless repealed; repeal sustained.
[2] Law required inspection once every four years.

Exhibit III - 4 **States Repealing PMVI Laws Since 1976**

tions. Most States participate in this program and receive grants to conduct roadside vehicle and driver inspections.

Four States have variations of motor vehicle inspection with more limited coverage of vehicles than a typical periodic vehicle inspection program. Maryland, in addition to a random system, inspects used vehicles prior to titling and initial registration and upon transfer of ownership. Together with random inspection, Wisconsin inspects used vehicles sold through dealers prior to sale. Non-PMVI Connecticut inspects vehicles registered in the State for the first time, vehicles ten or more years old when ownership is transferred, taxis, and vehicles declared "totaled" by insurance companies and subsequently rebuilt. While having no regular passenger car inspection, Illinois annually inspects commercial vehicles and *total loss* repaired vehicles before titling.

In addition to the PMVI States and the District of Columbia, 26 other States require at least an annual inspection of school buses for a total of 47 States, and the District of Columbia.

The States of Idaho, Nebraska, Tennessee and Wyoming do not have any law which provides for a safety inspection of motor vehicles other than school buses.

Of the States and the District of Columbia which require periodic motor vehicle inspection, only Delaware, the District of Columbia and New Jersey have government owned and operated inspection systems. The District of Columbia allows rejected vehicles to be reinspected by licensed garages and New Jersey allows vehicle owners to have their vehicles inspected at a State inspection station or at a licensed private garage. All other States have a State appointed and licensed garage system. Of these States, Rhode Island has a State-owned and operated check station. (See page 24 for a discussion of these systems).

Fourteen PMVI States and the District of Columbia also inspect for emissions in designated non-attainment air quality areas established by EPA and the States. Of the 33 States and the District of Columbia that have designated non-attainment air quality areas, eighteen inspect for emissions but do not inspect for safe vehicle condition (currently, there are 65 of these areas in the United States). See Exhibit III-5 for a listing of States with non-attainment air quality areas and PMVI and non-PMVI programs.

Combined Safety and Emissions Inspection: Of those States conducting safety and emission inspections, most already combine both inspection procedures. In the State Licensed or Appointed System, 12 States combine

State	Air Quality Urban Area	PMVI
Alaska	Anchorage, Fairbanks	No
Arizona	Phoenix	No
California	South Coast, Ventura, San Francisco, San Diego, Sacramento, Fresno, Bakersfield	No
Colorado	Denver, Colorado Springs, Fort Collins	No
Connecticut	Statewide	No
Delaware	Wilmington	Yes
District of Columbia	City-wide	Yes
Georgia	Atlanta	No
Idaho	Boise	No
Illnois	Chicago, East St. Louis	No
Indiana	Chicago suburbs, Louisville suburbs	No
Kentucky	Louisville, Cincinnati suburbs	No
Louisiana	Statewide	Yes
Missouri	St. Louis	Yes
Maryland	Baltimore, District of Columbia suburbs	No
Massachusetts	Statewide	Yes
Michigan	Detroit	No
Nevada	Las Vegas, Reno	No
New Hampshire	Nashua	Yes
New Jersey	Statewide	Yes
New Mexico	Albuquerque	No
New York	New York City	Yes
North Carolina	Charlotte, Raleigh	Yes
Ohio	Cincinnati, Cleveland	No
Oklahoma	Tulsa, Oklahoma City	Yes
Oregon	Portland, Medford	No
Pennsylvania	Philadelphia, Pittsburgh, Allentown/Bethlehem/Easton	Yes
Rhode Island	Statewide	Yes
Texas	Houston, Dallas, Fort Worth, El Paso	Yes
Tennessee	Nashville, Memphis	No
Utah	Salt Lake City, Provo	Yes
Virginia	District of Columbia suburbs	Yes
Washington	Seattle, Spokane	No
Wisconsin	Milwaukee	Yes

Exhibit III - 5 **Listing of States with Non-Attainment Air Quality Areas and with PMVI Programs**

safety and emissions inspection (see Exhibit III-6). These States use the idle mode test for emissions performed by emissions analyzers, in accordance with standards and procedures required by EPA. With some variation in the timing of the inspection for registration of new and used vehicles, these States conduct safety and emissions inspection at the same time. These safety and emissions inspection procedures also are followed by the three States that operate State owned and operated systems.

Adding emissions testing to safety inspection has been relatively simple and inexpensive. The experience of New Jersey, which has

State	State Licensed	State Owned and Operated	Combination of State licensed and State owned and operated	State Owned and contractor operated
Alaska	Emissions			
Arizona				Emissions
Arkansas	Safety			
California	Emissions			
Colorado	Emissions			
Connecticut				Emissions
Delaware		Safety & Emissions		
District of Columbia		Safety & Emissions		
Georgia	Emissions			
Hawaii	Safety			
Idaho	Emissions			
Illinois				Emissions
Indiana				Emissions
Kentucky				Emissions
Louisiana	Safety & Emissions			
Maine	Safety			
Maryland				Emissions
Massachusetts	Safety & Emissions			
Michigan	Emissions			
Mississippi	Safety			
Missouri	Safety & Emissions			
Nevada	Emissions			
New Hampshire	Safety & Emissions			
New Jersey			Safety & Emissions	
New Mexico	Emissions			
New York	Safety & Emissions			
North Carolina	Safety & Emissions			
Ohio	Emissions			
Oklahoma	Safety & Emissions			
Oregon		Emissions		
Pennsylvania	Safety & Emissions			
Rhode Island	Safety & Emissions			
South Carolina	Safety			
Tennessee				Emissions
Texas	Safety & Emissions			
Utah	Safety & Emissions			
Vermont	Safety			
Virginia	Safety & Emissions			
Washington				Emissions
Wisconsin				Emissions
West Virginia	Safety			
Total	**28**	**3**	**1**	**9**
	12 Safety & Emissions **9 Emissions** **7 Safety**	**2 Safety & Emissions** **1 Emissions**	**1 Safety & Emissions**	**9 Emissions**

Exhibit III - 6 **State PMVI and Emissions Inspection Systems**

implemented a combined safety and emissions inspection program since 1973, demonstrates the cost effectiveness of combining the two inspection procedures. The combination system has avoided the need to maintain more than one record of the inspection and to have more than one level of supervision. It also saves the consumer time and money because only one trip to the inspection facility is necessary.

The diagnostic inspection demonstration projects also demonstrated the feasibility of combining safety and emission inspection procedures. In these projects it was found that periodic diagnostic inspection and maintenance of rejected cars can be administered at low cost, and can provide helpful information to the consumer to obtain the needed repairs.

B. State Implementation Practices

All PMVI States specify the vehicle systems and equipment components that are to be inspected in their manuals of inspection or in their rules and regulations. While States generally agree on the overall vehicle systems that should be inspected, there is considerable variation in the specific equipment items inspected.

The situation prevails in spite of the uniformity recommended by the American Association of Motor Vehicle Administrators in its 1978 guidelines on equipment inspection and the NHTSA Vehicle-In-Use (VIU) standards issued in 1973. Exhibit III-7 summarizes the vehicle systems and equipment items inspected by States based on their manuals of inspection or rules and regulations.

The most common vehicle systems that States inspect are brakes, tires, steering, exhaust, lighting, signals and visibility. However, while 18 States inspect at least one component of the braking system, only nine States remove one wheel and four States remove two wheels to inspect the wear of linings/disc pads or excessive cylinder oil leakage. Eighteen States inspect for inadequate fluid level or leaking seals in the master cylinder. Three States inspect for side to side braking imbalance and 14 States require the vehicle to be driven for a road test. Most States inspect for headlamps, headlight aiming, stop lamps, tail lights, windshields, side and rear windows, and wipers. These components are easy to see and easy to inspect. About half of the States inspect body components such as doors, bumpers, and seat belts.

Although not reflected in the information obtained for this report, we expect that the States will also incorporate inspection requirements and procedures for new vehicle technology, such as anti-lock braking systems, airbags and four-wheel drive.

C. Factors Affecting State Implementation

One factor in determining the effectiveness of PMVI are the procedures followed in administering the program. This section discusses the most important procedures that could impact, either positively or negatively, on achieving the objectives of the program.

Type of Inspection Systems: Of the States that require PMVI, three types of systems are used. They are the State Licensed or Appointed, the State Owned and Operated, and a combination of the two. Of the States that require emissions inspection, an addi-

Vehicle Systems and Equipment Items Inspected	Number of States Inspecting Equipment Items	Percent of States Inspecting Equipment Items
Brakes		
Brake Failure Indicator	6	27
Pedal Pressure	13	59
Pedal Reserve	18	82
Linings	9	41
Fluid	18	82
Road or Platform Test	17	77
Parking Brake	19	86
Tires		
Treadwear and Damage	22	100
Mix of size and type on same axle	9	41
Wheels (Rims, Nuts, Discs, Hub Caps)	15	68
Steering and Suspension		
Ball Joint	12	54
Springs	14	64
Shock Absorbers	14	64
Freeplay	21	95
Linkage	14	64
Alignment	5	23
Fuel (Lines, Tank Cap)	11	50
Exhaust (muffler, exhaust, and tail pipe)	21	95
Lighting and Signals		
Headlamps	22	100
Beam Aim	17	77
Beam Indicator	15	68
Stop Lamps	22	100
Tail Lamps	22	100
Turn Signals	22	100
License Plate Lamps	14	64
Reflectors	14	64
Horn	22	100
Visibility		
Windshields	20	91
Side and Rear Windows	20	91
Mirrors	16	73
Defroster/Defogger	4	18
Wipers	22	100
Washer	4	18

Exhibit III - 7 **Summary of Vehicle Systems and Equipment Items Inspected by States (Part I)**

Vehicle Systems and Equipment Items Inspected	Number of States Inspecting Equipment Items	Percent of States Inspecting Equipment Items
Body Components		
Doors	13	59
Floor Pan	12	54
Seats	10	45
Hood Latch	13	59
Seat Belts	13	59
Head Restraints	0	0
Bumpers	12	54
Fenders	12	54

Exhibit III - 7 **Summary of Vehicle Systems and Equipment Items Inspected by States (Part 2)**

tional type of inspection system, the State Owned and Contractor Operated, is also used (see Exhibit III-6).

Under the State Licensed or Appointed System, the private station owner and the inspector become agents of the State, and they are expected to perform inspections according to requirements established by the State. The designation of official inspection stations usually follows the filing of an application with the State agency responsible for the program. Each applicant is investigated to determine whether his/her business meets space, manpower and equipment requirements.

The inspection standards and procedures are specified by the State. Once a vehicle passes the required inspection, stickers are issued by the station and placed on the windshield to aid law enforcement officers in identifying vehicles that are in or out of comformance with inspection requirements. If a vehicle is found to be unsafe, repairs are required within a designated time period, and the vehicle must be resubmitted for inspection before a sticker is issued. No enforcement authority is delegated to the stations.

Supervision of these stations and inspectors is usually carried out by the officers of the State Police, Highway Patrol, or by authorized personnel of the Department of Motor Vehicles. Supervisory personnel are usually assigned several stations to monitor, with the number varying widely from State to State. Monitoring procedures may range from only responding to complaints received from the public to sending vehicles covertly with known failures through the inspection stations.

If facts are discovered that lead officials to believe that unsafe vehicles are being passed, or that stations are requiring unnecessary repairs, States have the authority to revoke or suspend the station's license.

The costs entailed in the supervision of these private stations are covered by income from a portion of the inspection fee, and from the sale of stickers and inspection signs to the authorized stations.

The State Licensed or Appointed System is used by 19, or 90 percent of the PMVI States, and by 21, or 62 percent of the States that inspect for emissions.

Under the State Owned and Operated System, the State assumes complete responsibility for the program. The State purchases or leases the building and equipment, employs and trains civil service personnel, and exercises direct control of the inspection and supervisory procedures. The vehicle systems and equipment items inspected are generally the same as those in a State Licensed or Appointed System.

The design of these facilities permits the use of inspectors who specialize in performing the inspection tasks repetitively as the vehicle passes through the lane. If failures are detected, repairs or adjustments are made in private repair facilities, and the vehicle must be re-inspected. Windshield stickers are given to each vehicle that passes inspection as in the State Licensed or Appointed System. This system is used by two PMVI States and by four emission inspection States.

Currently, one State, New Jersey, uses a Combination of State Licensed and State Owned and Operated for both safety and emissions inspection. The District of Columbia uses a modification of the State Owned and Operated System by allowing motorists with rejected vehicles to have them re-inspected by a State Appointed and Licensed station.

Under the State Owned and Contractor Operated System, no PMVI State uses the system for safety inspection, but nine States use it for emissions inspection.

The Contractor system is similar to the State Owned and Operated System and is subject to the advantages and disadvantages of that system. Further advantages would be: (1) the initial cost of land, equipment and people would be borne by the contractor, (2) lead time to develop procedures and schedules for implementation would be reduced and (3) more sophisticated equipment and new equipment due to new technology could be more readily used.

Program Management Practices: Most States have chosen the State Licensed and Appointed System as the preferred way to implement mandatory motor vehicle inspection programs. However, a number of problem areas have been identified which generally arise from allowing these same inspection stations to perform the repairs.

The following addresses the management of a State Licensed and Appointed system, based on the review of current State practices, an assessment of States' problems, and the ways the States resolve them.

There are several different organizational structures that States use for the administration of their PMVI programs. Some organizations have omitted functions, such as public relations, training orientation and field supervision. Several States have overlaid the PMVI program onto existing organizations. Often, the lack of equal program status or priority results in lowered effectiveness. In some cases, criteria do not exist for selection of supervisory or other personnel. As a result, people are assigned to jobs without the necessary technical qualifications.

Legislation which creates the PMVI program normally provides the authority to make and issue rules, to administer and enforce the rules and regulations and to adjudicate disputes. Several State programs suffer from (1) not having regular services of a legal advisor, (2) failure to understand the extent of legal authority, (3) no clear procedures for conducting hearings, and (4) not using

rulemaking authority enough to announce agency policies and procedures.

States using the State Licensed or Appointed System both license and certify the inspection stations. Weaknesses in this process include: (1) approval of an unlimited number of stations, requiring more supervisory personnel which, in practice, has led to shortages, (2) background investigation has not been thorough, and (3) station owners/managers are not required to have a full understanding of the inspection procedures to obtain a license.

Training is used to help inspectors acquire the attitudes, knowledge, and hands-on experience needed to carry out the inspection tasks, while certification establishes that they have the required knowledge and skills. Weaknesses include: (1) lack of established policy recognizing the need for training has led to variations in skill levels of inspection and uneven interpretation of State vehicle inspection procedures between stations, (2) often, training does not include hands-on experience and (3) training programs format and content often are not revised based on experience and changes in State laws.

Field supervisors are responsible for ensuring that inspections are performed properly, inspection equipment is in good condition and is calibrated, and information is communicated between stations and inspectors. Weaknesses are that: (1) in some States there is no formal selection or screening system, and often the only training is on-the-job, (2) multiple duties are assigned which present conflicts in priority, and (3) a lack of specified procedures result in inconsistent supervision between stations.

Resistance to PMVI usually develops when people perceive a lack of uniformity and inadequate inspection of the vehicle systems and components. A well developed and implemented public information and education program is central to gaining and sustaining public support for PMVI. Weaknesses in such programs are: (1) motorists, the media and others are not made aware of the accomplishments of the program and of the techniques for assuring proper inspections and repairs and for proper vehicle maintenance practices, (2) motorists are not made aware of effective procedures for filing complaints, and (3) administrators take a reactive or defensive position when dealing with the media.

Planning, reporting, and evaluation are important in assessing the overall operation of the program and in the achievement of goals and specific objectives. Weaknesses of planning are: (1) objectives are not established or specified, (2) future needs are not assessed, and (3) people who do the planning and individuals who do the work frequently do not communicate with each other. Weaknesses of reporting are: (1) lack of access to PMVI data because they reside with other agencies, and (2) delays in obtaining data prevent timely action and handling of complaints. Weaknesses of evaluation are: (1) failure to use appropriate criteria and procedures, and (2) failure to evaluate all parts of the program to identify problems.

Factors that affect acceptance and non-acceptance of PMVI programs depend to a large extent on public perception of the value of PMVI as a highway safety program, compared to the cost of the program in both time and money. While a large number of States accept PMVI, a large number of States do not accept the program.

The States that accept PMVI as a highway safety program cite two major factors:

PMVI provides for safer vehicles by detecting component failures and by requiring their correction, thereby reducing the number of crashes; and PMVI assists the driver in understanding the periodic maintenance requirements of motor vehicles.

These States are aware that there is some inconvenience to the public involving some costs, but they believe that the benefit of safer vehicles through compulsory inspection are much greater than the costs. These States consider vehicle safety to be part of their overall safety effort. Several of them have reported that a number of people rely on the scheduled inspection to maintain their vehicles in a safe condition.

State emphasis on regular supervision of the inspection stations, together with training of the inspectors reinforces public acceptance of the program in a State-licensed system. These States perceive that the public judges the program by the effectiveness of the station and inspector in conducting the inspection. Also, in these States, complaints, when they occur, are investigated and resolved expeditiously.

Generally, in these States, newspaper editorials, associations of automobile owners, garages, repairers, highway users and others, and State departments or agencies such as the Highway Patrol, Motor Vehicles, Insurance, Education, Environmental Protection and the Attorney General support the PMVI program.

The States that do not accept PMVI frequently cite the lack of data showing that vehicle failures cause or contribute to crashes or that PMVI reduces crashes. Other factors that have been cited are: costs are too high for the benefits gained; lack of sufficient public interest and legislative support; occurrence of abuses in a State appointed or licensed system; and lack of sufficient supervisory resources to monitor the program effectively.

The general belief of the non-PMVI States is that the costs are greater than the safety benefits of vehicle inspection to the motorist and to the State; there is no public outcry for enacting a PMVI law; and governmental intrusion is unnecessary. The non-PMVI States that repealed PMVI laws generally cite the withdrawal of Federal sanctions against States without PMVI, the lack of data justifying the program, and problems with maintaining the integrity of the State-licensed system.

In addition, based on our site visits to States that had PMVI laws and then repealed them during the period of 1976-1982, specific factors indigenous to each State were decisive in the non-acceptance of the program. In one State long waiting lines for inspection in a government operated system led to legislative support to repeal the program. In another State, an alternative program, mandatory inspection at time of transfer of vehicle ownership, was implemented to prevent the dumping of unsafe and old vehicles in the State because the surrounding States implemented PMVI programs. In this State, the legislature has strengthened and has expanded the program by including additional types of vehicles such as motorcycles, trucks and buses. The crash data obtained from police accident reports in this State indicate a low association of vehicle failures with crashes, and thus has been a factor in the non-enactment of a PMVI law.

In two other non-PMVI States, the legislatures questioned existing PMVI programs because of newspaper and television reporting of under- and over-inspection, and the

fraudulent sale of approval stickers. These problems along with the observations that not all States require PMVI; lack of adequate data to justify the program; and the administrative problems associated with enforcing rules and regulations all contributed to the non-acceptance of PMVI.

D. Federal Role

In June 1967, under the authority of the Highway Safety Act of 1966, the Department issued among other standards, the Periodic Motor Vehicle Inspection Highway Safety Program Standard, which required that all registered vehicles be inspected at least once a year in accordance with criteria issued or endorsed by NHTSA (or at such other time as may be designated under a project approved by the Secretary). Under the authority of the National Traffic and Motor Vehicle Safety Act of 1966, on August 29, 1973, NHTSA issued Vehicle-In-Use (VIU) Inspection Standards covering brakes, tires and wheels, and steering and suspension. These standards are incorporated in the PMVI Highway Safety Program Guidelines.

Congress addressed further concerns about vehicles-in-use when it enacted Title III of the Motor Vehicle Information and Cost Savings Act of 1972. This Title provided for demonstration projects designed and operated to conduct periodic safety and emission inspections and to provide specific technical diagnosis of each vehicle inspection in order to facilitate correction of any component failing inspection.

In 1975, the Administrators of NHTSA and FWHA stated their policy concerning approval of highway safety programs in certain States for FY 1976. These States were deficient in having a mandatory motorcycle helmet use law, a program for periodic motor vehicle inspection, and/or a classified driver license. Thus, the Administrators began proceedings to consider withholding highway construction and highway safety funds from California, Illinois, and Utah, in this case, for their failure to enact a law requiring all motorcycle riders to wear helmets. Subsequently, the enactment of the Highway Safety Act of 1976, among other provisions, eliminated authority for the Secretary to withhold ten percent of a State's highway construction funds for failing to obtain an approved highway safety program.

In response to Congressional direction to review the program, a principal recommendation was made to Congress in the report, *An Evaluation of the Highway Safety Program, A Report to the Congress*, from the Secretary of Transportation dated July 1977. It stated that:

> *"In the future, greater reliance must be placed upon State and local highway safety agencies to identify their most pressing problems and advance appropriate solutions to them."*

Subsequently, eleven States repealed their Periodic Motor Vehicle Inspection laws and several States reduced the frequency of inspection and eliminated some equipment items of inspection.

Reflecting concern about the multiple programs funded under the State and Community Highway Safety Grant Program, Congress, in the Omnibus Budget Reconciliation Act of 1981 directed the Secretary of Transportation to determine the most effective highway safety programs in reducing crashes, injuries and fatalities.

A final rule was issued in 1982, identifying the six most effective NHTSA and FHWA highway safety programs, and providing for the continued eligibility of those programs for Federal funding. The NHTSA programs identified were: Alcohol Countermeasures, Occupant Protection, Police Traffic Services, Emergency Medical Services, and Traffic Records. The FHWA program identified was Safety Construction and Operational Improvements. In the Surface Transportation and Uniform Relocation Assistance Act of 1987, Congress again directed NHTSA and FHWA to determine the programs currently most effective in reducing crashes, injuries and fatalities. In a final rule issued April 1, 1988, Motorcycle Safety was added to the priority program areas identified in the 1982 rule. At the same time, Alcohol Countermeasures was changed to Alcohol and Other Drug Countermeasures, and the FHWA program was renamed Roadway Safety. It should be noted that in the 1988 rulemaking, no State agency supported PMVI as a priority program. Only one commenter from the private sector recommended that PMVI should be added to the priority programs.

Although PMVI was not included as a priority area, the rule provides that it (and other non-emphasis areas) can receive funding in accordance with non-emphasis area funding procedures established in the rule. Thus, although the Federal role in funding PMVI has diminished over the past decade, State and Community Highway Safety Grant Program funds can still be approved for Federal funding of PMVI programs, with sufficient justification relative to crash reduction benefits.

Another part of the Surface Transportation and Uniform Relocation Assistance Act of 1987, Section 206(a) amended the language in the original Act, which required the States to comply with Federal Standards, one of which was the Periodic Motor Vehicle Inspection Standard. In this action, Section 402 of the Act for State and Community Safety Grants was amended by replacing the term *standard* and *standards* wherever they appear with the words *guideline* and *guidelines*. NHTSA has changed its regulations to reflect this amendment.

SECTION IV

NHTSA DATA ANALYSIS

Analysis Using Crash and Registration Data: The analysis of motor vehicle accident data that follows compares the crash involvement rates (crashes per registered vehicle) of passenger cars of varying ages in states with and without PMVI programs. On the basis of the comparison between these two groups of states, inferences on the effectiveness of PMVI in reducing crashes can be made. The mechanism is that PMVI programs are effective in preventing motor vehicle crashes by maintaining the mechanical condition of older cars; mechanical failures cause crashes; thus PMVI, by maintaining mechanical condition, reduces the number of crashes that would otherwise occur.

That is, if other factors which can affect crash involvement are equal:

- As vehicle age increases, the condition of components critical to safety deteriorates and thus the likelihood of crash involvement as a result of mechanical failure increases.

- One effect of PMVI is to maintain the mechanical condition of these critical components, thereby reducing the likelihood of crashes resulting from mechanical failure.

- If this mechanism is occurring, and if the PMVI effect is large, the relative crash involvement rate of old to new vehicles in PMVI states will be lower than the relative involvement in non-PMVI states. Differences in the crash involvement rates of newer vehicles in PMVI as compared to non-PMVI states would not be expected because they would have not been in service long enough for significant wear of mechanical components to occur.

Analytic Method: The method of analysis employed in this assessment is based on a comparison of crashes per registered passenger car by model year for PMVI and non-PMVI States. This comparison tests for differences in crash involvement rates as a function of vehicle age between the groups of States (PMVI and non-PMVI). Higher relative rates for older vehicles in non-PMVI States, as opposed to PMVI States, would suggest a PMVI effect.

The use of crash involvement rates, rather than the absolute number of crash involvements, compensates for differences in the number of vehicles of different ages among States which could affect this analysis. For example, residents of some States, because of particular socio-economic characteristics, may tend to own older vehicles than residents of other States. As a consequence, the proportion of crashes involving older model year vehicles in these States would be greater than in States with a larger relative population of newer vehicles, regardless of whether or not that State required PMVI. The use of crashes per number of registered vehicles addresses such an exposure difference. It should be emphasized, however, that even differences in crash involvement rates resulting from this analysis cannot be considered conclusive. Many factors could account for differences in crash involvement rates other than the existence of a vehicle inspection program. These include different demographics of drivers, different socio-economic characteristics and different driving patterns. However, significantly higher involvement rates for older vehicles compared to newer vehicles in non-PMVI as opposed to PMVI States, would suggest a PMVI effect.

Crash involvement rates for both fatal and all crashes (all refers to all police reported

crashes - from property damage only through fatal) were utilized in this analysis. Fatal crash involvements by passenger car model year were obtained from the Fatal Accident Reporting System (FARS) which is a census of all fatal motor vehicle crashes in the United States occurring on a public roadway in which a death occurs within 30 days of the crash. Data in FARS are provided to NHTSA by each of the 50 States and the District of Columbia. The information in FARS is obtained from police accident reports and other official State sources. Fatal crash involvements are the only crash data presently available from all States. As such, they are the only crash data which can be used for a national analysis. It should be noted, however, that fatal crash data are not well suited for examining programs designed to prevent crashes such as PMVI, because they are limited to extremely severe crashes, i.e., those in which at least one person is fatally injured. As such, they are of limited utility in studying the overall crash involvement propensity of motor vehicles. Further, fatal crashes are rare (about 0.7% of all police reported crashes), and occur under conditions which differ from those found in the general crash environment. Stated differently, the FARS data set is principally a crashworthiness file - it contains crashes severe enough to generate forces on the human body that are greater than the body tolerance. Thus, FARS is helpful in assessing crash factors which can cause fatal injury. It is of limited value in assessing crash avoidance issues - those factors which are associated with crash involvement. PMVI, by its nature, is a crash avoidance issue, so the limitations of FARS data must be recognized. The use of these fatal data, however, is warranted by the following considerations:

- They are the only source of crash data for all States available to NHTSA.
- They are largely unaffected by crash severity threshold reporting biases.

As a complement to the national FARS data set, State accident files from 10 States were utilized in the assessment; four with PMVI programs and six without. These States were selected on the basis of several criteria, including:

- Willingness to provide NHTSA accident data.
- Accident data readily accessible in automated form.
- Information on vehicle model year.
- Identification of crash involved parked vehicles. Parked vehicles were excluded from the analysis.

These limitations on the availability of State data could impact the analysis in several important ways. First and foremost, findings are constrained by the characteristics of these States and their crash experience. Results may be different if other States were employed in the analysis, or if all 50 States were included. Second, differences in reporting criteria could account, in part, for differences observed in crash rates. For example, if older vehicles tend to be damaged more severely than newer vehicles, then a State with a lower damage threshold for reporting crashes to police would report proportionally more crashes involving older vehicles compared to a State with a higher damage threshold, regardless of whether or not that State required PMVI. As indicated previously, however, police reported crashes are the only source of information on crashes of all severities.

Calculation of Involvement Rates: Crash involvement rates in both fatal and total crashes were calculated on a per registered vehicle basis for passenger cars only. Vehicles other than passenger cars routinely used to transport passengers such as light trucks, vans, and utility vehicles were not considered to be passenger cars in this analysis.

Registration data were obtained from R.L. Polk for each State as of July 1, each year, and represent the number of registered vehicles, by model year, in each State on that date. The number of crash involvements by model year, both fatal and from the 10 State accident files, were tabulated for the 12 months immediately following this count (July 1 to June 30).

Crash Rate Comparisons: Crash involvement rates were evaluated using two approaches:

- Across model years for a single 12 month crash period (for both fatal and total crashes).
- Across crash years for a single model year (for fatal crashes only).

In the first, the crash involvement rate of 1972 through 1985 model year vehicles was calculated by model year for the same 12 months. This approach assesses the relationship between vehicle age and crash involvement rates. The result is a crash involvement rate for each model year, 1972-1985, for the PMVI group of States and the non-PMVI group. Comparison of these two crash involvement rate trends is used to provide insight into the role of PMVI in crash involvement. This approach has the advantage of comparing crash involvement rates among all model years in PMVI and non-PMVI States within a common time frame. A disadvantage is that it does not provide the crash involvement rate trend of a particular model year over time.

In the second approach, the crash experience of a single model year (1975) was examined over 11 crash years (1976 - 1986). This approach assesses the change in the crash involvement rate of a particular model year over time. Comparing the changes in the rate over time relative to the 1976 rate, between PMVI and non-PMVI States, provides further insight into the relationship between PMVI and crash involvement. This approach has the advantage of monitoring the 10 year crash involvement rate of a single model year over time in PMVI and non-PMVI States. It is, however, limited to only one model year. Additionally, the data can be affected by changes in police accident reporting threshold changes over this 11 year period.

Both approaches were undertaken in the analysis of fatal crash involvement rates. State data were used in the first approach only because data required to calculate crash rates for a single model year over ten crash years were available from only two States.

In all comparisons, model year crash involvement rates in PMVI States were compared to model year crash involvement rates in non-PMVI States. As stated previously, the basic concept underlying these analyses is that PMVI effects, if they are measurable, should be reflected in lower involvement rates for older vehicles relative to new vehicles in PMVI, as opposed to non-PMVI, States.

Overview of PMVI Program Characteristics: States vary greatly in the methods by which they operate PMVI programs. Some inspect all vehicles on a regular basis,

others only when the vehicle is sold. Still other States inspect vehicles randomly. A number of States have no PMVI program.

States also differ in the manner in which inspection of the vehicle is accomplished. Not all States inspect the same mechanical components and equipment items, nor do they inspect vehicles in the same manner. Some States measure whether or not selected components are in tolerance, others simply test to see if the component functions properly. The large number of possible combinations of items inspected, inspection procedures, and other program characteristics lend a unique character to each State's PMVI program. For this reason, it is difficult to compare States' PMVI programs in all but the broadest terms.

Analysis of Fatal Crash Involvement Rates: Presented in the following sections are results of the analysis of fatal crash rates:

- Across model years for the same one-year crash period.
- Across crash years for the same model year.

Except for 1985, involvement rates for the *across model year analysis* are based on the number of registered vehicles in each State as of July 1, 1985. Fatal crash involvements for each model year were tabulated for the 12 months immediately following this date (July 1, 1985 to June 30, 1986). Involvement rates for 1985 model year vehicles are based on registrations as of July 1, 1986.

Comparison of Fatal Crash Rates Across Model Years in a One-Year Crash Period: Presented in Exhibit IV-1 are fatal crash involvement rates in aggregate for the 27 States with no PMVI program, and 22 (21 States and the District of Columbia) with PMVI. Also shown in Exhibit IV-1, for each group, is the fatal crash involvement rate for all model years combined. Data are from 1985-1986 FARS. States with random *spot* inspection programs are considered as having no inspection program for the purposes of this analysis because of the small number of vehicles actually inspected. Two States (Maryland and Connecticut) which require vehicles to be inspected only with a change in ownership are not included in either group. Rates are calculated for passenger car model years 1972 through 1985. Exhibit IV-2 presents these data graphically, while Exhibit IV-3 presents the data for both groups of States (PMVI and non-PMVI) normalized to 1985 model year rate for each group. This method of presentation provides a more graphical indication of whether involvement rates for older vehicles are increasing or decreasing with respect to the involvement experience of the newest vehicles in each group. Values greater than 1.00 indicate that the crash involvement rate of specific model years is greater than that experienced for 1985 vehicles, values less than 1.00 indicate the opposite.

Crash involvement rates per registered vehicle are presented in Exhibits IV-2 and IV-3, for both PMVI and non-PMVI States. These data indicate there is considerable variation in crash rates, for both PMVI and non-PMVI States, across vehicle model years. Crash rates are higher in PMVI States (compared to non-PMVI States) for some model years, and lower in others. There is no clear indication in either data set that crash involvement rates across vehicle model years are consistently different in non-PMVI States, compared to PMVI States.

Test of Differences Between PMVI and Non-PMVI States: A test of the significance of

Model Year	Non-PMVI*	PMVI
1985***	29.4	28.8
1984	28.9	30.2
1983	27.7	27.4
1982	29.4	29.0
1981	27.7	28.7
1980	27.9	28.8
1979	28.0	28.1
1978	27.4	29.3
1977	29.8	28.6
1976	30.7	27.7
1975	30.3	28.1
1974	30.1	28.7
1973	28.5	26.7
1972	29.4	29.7
All**	28.6	28.4

* Includes States with random inspection programs

** Includes data for pre-1972 model year vehicles

*** Registrations for 1985 model year are as of July 1, 1986

Exhibit IV-1 **Fatal Crash Involvement Rates for Passenger Vehicles (July 1985 through June 1986) per 100,000 Registered Vehicles (Registered as of July 1985)**

differences among involvement rates for each of the model years considered in this analysis was performed using a Chi Square test of independence. This test was performed by contrasting the number of fatal crash-involved and crash-free cars in PMVI States with coinciding counts in non-PMVI States for each model year. Large differences in these proportions are an indication that differences in fatal crash involvement rates between PMVI and non-PMVI States for a given model year are not due to chance factors. The results of this analysis are presented in Exhibit IV-4. Presented are Chi Square values, associated probabilities, and an indication of the direction of differences in rates.

As can be seen, in only two comparisons were differences in the crash involvement rates found to be significant using this test. In one case, PMVI States were found to have a significantly higher crash involvement rate, in the other a significantly lower fatal crash involvement rate. Differences noted for all other model years appear to be chance dif-

Exhibit IV-2 **Fatal Involvement Rates for Passenger Cars (per 100,000 registered vehicles).**

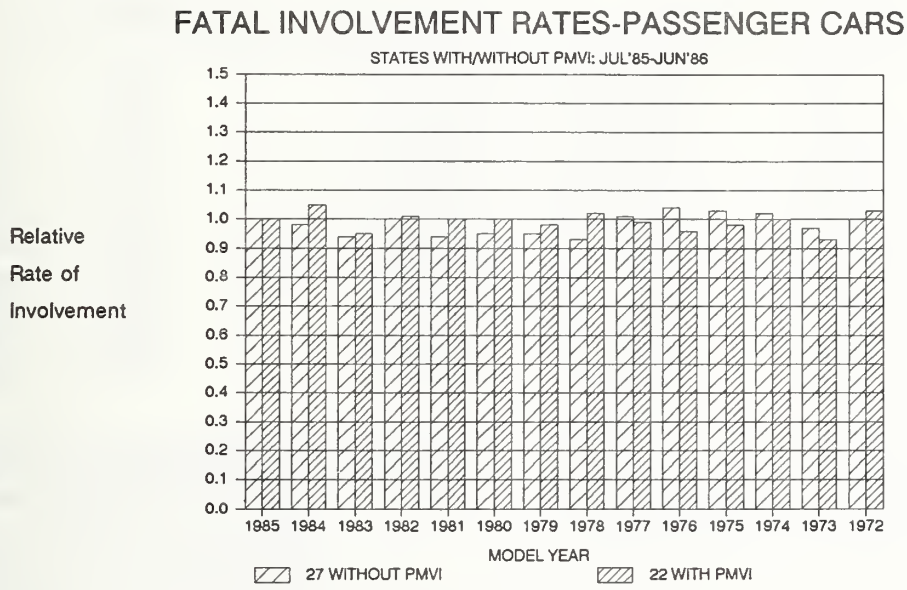

Exhibit IV-3 **Fatal Involvement Rates for Passenger Cars (relative involvement rates)**

ferences, and not statistically significant. These results do not suggest a PMVI effect on the fatal crash involvement rate.

Comparison of Fatal Crash Rates Across Crash Years: Fatal crashes per 100,000 registrations for 1975 model year passenger cars are presented in Exhibit IV-5 for crash years 1976 through 1986. A graphic representation of the relationship between vehicle age and crash involvement can be obtained by examining relative fatal crash involvement rates. Presented in Exhibit IV-6 and Exhibit IV-7 are rates of involvement by crash year for 1975 passenger cars, relative to their rate in 1976. These data reflect a general decrease in relative fatal crash rates as vehicles age. This decline is evident for both PMVI and non-PMVI States. Two findings are evident from these data. First, there is clearly no trend for crash involvement rates to increase with age in either PMVI or non-PMVI States. Second, and more germane to the PMVI effectiveness issue, there is no obvious difference in the crash involvement rate trend between non-PMVI States and PMVI States.

Model Year	Chi-Square	Probability	Direction
1985	0.236	0.66	none
1984	1.366	0.25	none
1983	0.051	0.84	none
1982	0.010	0.76	none
1981	0.757	0.41	none
1980	0.499	0.49	none
1979	0.001	0.98	none
1978	2.848	0.09	PMVI +
1977	0.946	0.36	none
1976	5.012	0.03	PMVI-
1975	1.946	0.18	none
1974	0.900	0.37	none
1973	1.329	0.25	none
1972	0.016	0.90	none

Exhibit IV-4 **Chi-Square Analysis of Fatal Crash Involvements in Selected States**

Crash Year	Non-PMVI	PMVI
1976	43.7	44.6
1977	46.1	45.0
1978	43.7	43.0
1979	41.8	41.6
1980	43.2	43.4
1981	29.6	34.0
1982	27.1	31.5
1983	27.4	30.4
1984	29.0	28.8
1985	28.8	28.6
1986	31.3	29.5

Exhibit IV-5 **Fatal Crash Involvement Rates for 1975 Model Year Passenger Cars in Non-PMVI and PMVI States**

Crash Year	Non-PMVI	PMVI
1976	1.00	1.00
1977	1.06	1.01
1978	1.00	0.96
1979	0.96	0.93
1980	0.99	0.97
1981	0.68	0.76
1982	0.62	0.71
1983	0.63	0.68
1984	0.66	0.65
1985	0.66	0.64
1986	0.72	0.66

Exhibit IV-6 **Relative Fatal Crash Involvement Rates for 1975 Model Year Passenger Cars in Non-PMVI and PMVI States (Relative to 1976)**

An analysis of differences in crash involvement rates by year between PMVI and non-PMVI States was performed using a Chi Square test of independence. This test was performed by contrasting the number of crash-involved and crash-free cars in PMVI States with coinciding counts in non-PMVI States for each model year. The results of this analysis are presented in Exhibit IV-8. Shown are Chi Square values, associated probabilities, and an indication of the direction of differences in rates.

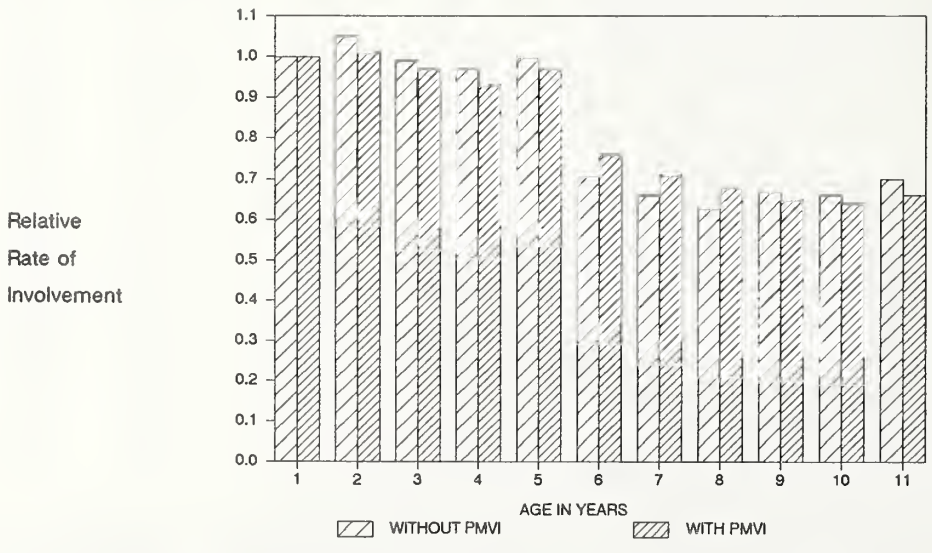

Exhibit IV-7 **Involvement Rates by Crash Year for Model Year 1975 Passenger Cars Relative to Their 1976 Crash Experience**

Crash Year	Chi-Square	Probability	Direction
1976	0.269	-	none
1977	0.374	-	none
1978	0.145	-	none
1979	0.009	-	none
1980	0.011	-	none
1981	8.130	<.005	PMVI +
1982	8.007	<.005	PMVI +
1983	3.849	<.05	PMVI +
1984	0.020	-	none
1985	0.015	-	none
1986	0.839	-	none

Exhibit IV-8 **Analysis of Crash Involvements for Model Year 1975 Passenger Cars**

As is apparent, while there are a few significant differences, there is no trend supportive of a PMVI effect.

The conclusion using the second approach - across crash years for the same model year - is the same as before. These data provide no evidence that States with PMVI have a reduced crash involvement rate for older vehicles relative to newer vehicles, compared to States without PMVI.

Analysis of Total Crash Involvement Rates: Ten States were used in the analysis of overall crash involvement rates in PMVI and non-PMVI States. Factors governing the selection of these States have been previously discussed. Six States comprised the group of non-PMVI States; California, Colorado, Florida, Illinois, Kansas, and Washington. Four States made up the PMVI group; Louisiana, Missouri, Pennsylvania, and Texas. Crash involvement rates by model year per 1,000 registered vehicles for both groups are presented in Exhibit IV-9.

These data indicate that crash involvement rates are always higher in non-PMVI States,

Model Year	Non-PMVI Rate	PMVI Rate
1985	73.5	60.3
1984	69.3	59.8
1983	65.7	55.5
1982	66.5	57.1
1981	64.2	55.3
1980	63.8	54.3
1979	66.6	56.0
1978	65.9	54.4
1977	66.0	52.6
1976	67.1	52.3
1975	64.7	50.7
1974	60.5	48.8
1973	57.7	46.5
1972	59.3	49.4
Overall*	63.7	53.3

* Includes data for pre-1972 model year vehicles

Exhibit IV-9 **Total Crash Involvement Rates by Model Year**

regardless of model year. This is clearly inconsistent with the anticipated effects of PMVI programs, as there should be no differences in the crash rates of newer vehicles between PMVI and non-PMVI States.

In testing for possible differences in involvement rates between PMVI and non-PMVI States, it was assumed that the large difference noted in crash involvement rates in later model years was due, in part, to higher reporting thresholds for the PMVI States used in this analysis, resulting in fewer crashes being reported. To adjust for this bias, rates for PMVI States were increased by an amount equal to the difference in overall rates between PMVI and non-PMVI States. The difference in overall rates was considered to be the best available method of correcting for this bias.

Model Year	Non-PMVI Rate	PMVI Rate	Chi Square	Probability	Direction
1985	73.5	70.6	124.02	.005	PMVI-
1984	69.3	70.1	11.65	.005	PMVI +
1983	65.7	65.9	0.19	.680	none
1982	66.5	67.5	11.45	.005	PMVI +
1981	64.2	65.5	28.49	.005	PMVI +
1980	63.8	64.6	9.14	.005	PMVI +
1979	66.6	66.4	0.81	.400	none
1978	65.9	64.8	18.72	.005	PMVI-
1977	66.0	62.9	131.15	.005	PMVI-
1976	67.1	62.6	220.86	.005	PMVI-
1975	64.7	61.0	101.25	.005	PMVI-
1974	60.5	59.2	14.78	.005	PMVI-
1973	57.7	56.8	6.87	.010	PMVI-
1972	59.3	59.7	1.25	.270	none

Exhibit IV-10 **Chi Square Analysis of Total Crash Experience in Selected States**

The adjusted crash involvement rates and the results of a Chi Square test of independence applied to this adjusted data are presented in Exhibit IV-10. Shown are adjusted rates, Chi Square values, associated probabilities, and an indication of the direction of differences in rates.

While older cars in PMVI States (1973-1978) tend to experience significantly lower crash involvement rates in comparison to their counterparts in non-PMVI States, as would be expected if PMVI programs were effective, newer cars in these same States have significantly higher crash involvement rates. This latter finding is clearly inconsistent with the general hypothesis of PMVI effectiveness tested in this analysis. There should be no difference in crash involvement rates for newer cars between PMVI and non-PMVI States.

A more direct test for this trend was performed by evaluating the slope of regression lines for PMVI and non-PMVI States. Unadjusted crash involvement rates were used in this analysis. In both cases, the slopes were found to differ significantly from zero (p.001), indicating that crash involvement rates change with vehicle age. However, the slopes were not found to differ significantly from one another, indicating that the rate of change in PMVI States does not differ from that observed in non-PMVI States. This would not be expected if PMVI were effective in preventing crashes.

Exhibit IV-11 indicates that, relative to their involvement rate for a 1985 vehicle, PMVI States have higher involvement rates for model years 1984 - 1979, and lower involvement rates for model years 1977 - 1972, compared to non-PMVI States. This figure does not suggest any PMVI effect on crash involvement rates.

Conclusions: There appears to be no evidence in the crash data examined in this analysis which would suggest that PMVI programs affect the crash involvement rates of older vehicles compared to newer vehicles.

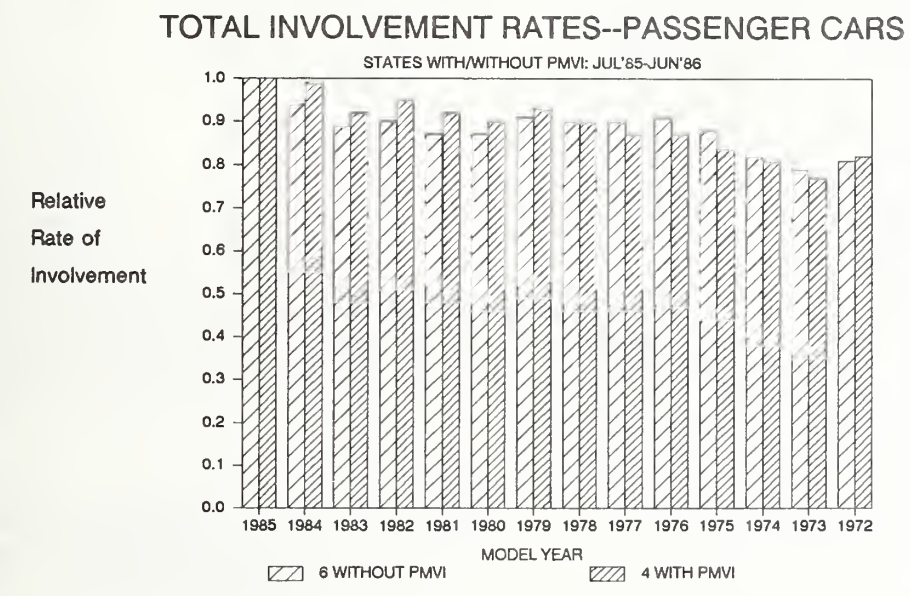

Exhibit IV-11 **Total Involvement Rates for Passenger Cars by Model Year**

This conclusion is based on the following findings:

- The fatal crash involvement rate of older vehicles compared to new vehicles is not significantly different between PMVI and non-PMVI states.

- State data files on total crash involvement do not indicate a difference between the crash involvement rate, by model year, in PMVI compared to non-PMVI states.

Analysis Using CARDfile: In addition to the crash involvement rate analysis, data from the Crash Avoidance Research Data file (CARDfile) were analyzed. Unlike the involvement rate analysis, which uses actual crash counts and vehicle registration counts, the CARDfile data are based upon the reporting of a vehicle component failure by the investigating police officer. That is, the measure used in this analysis is the percentage of crash involved vehicles in which a component failure was reported.

CARDfile contains data from six States on approximately 4 million crashes involving approximately 7 million vehicles. This represents the police-reported crash experience of the most recent three years of data available (1984-1986) at the time the analysis was performed. States currently included in CARDfile are Indiana, Maryland, Michigan, Pennsylvania, Texas, and Washington.

CARDfile is not a national probability based sample of crashes. Its value is as a database for relating vehicle design characteristics to crash propensity. About 5.2 million (71 percent) of the vehicles in CARDfile are passenger cars. One feature of CARDfile is that it identifies vehicles coded by police officers as having a component failure which was suspected of contributing to the crash.

In this analysis, data from two of the six States were excluded. Michigan data were excluded because only one type of component failure (tire puncture/blowout) is coded in the Michigan State file. Indiana data were excluded because more than 50 percent of the component failure items were coded as missing or unknown. Neither Michigan nor Indiana have PMVI programs.

A total of 2,202,674 crash involved passenger cars was examined -- 578,732 of the vehicles were in non-PMVI States (Maryland and Washington), and 1,623,902 of the vehicles were in PMVI States (Pennsylvania and Texas). Only crash involved passenger cars ranging in age from 0 (brand new) to 10 model years old were examined. All passenger cars older than ten model years were excluded from the analysis.

In the CARDfile analysis, the percentage of crashes involving a reported component failure is calculated. Five categories of component failures were identified for study - defective brakes, defective steering mechanism, defective or improper lights, worn or defective tires, and all other defects. Other component failures, such as defective, broken, shattered or dirty windshields, were not coded in the CARDfile and hence, could not be analyzed.

The percentage of passenger cars age 0 to 10 years with any component failure identified in non-PMVI States and PMVI States is shown in Exhibit IV-12. Percentages shown are the percentage of all crash involved cars that were identified by the investigating officer as having a component failure which contributed to the crash. As can be seen in Exhibit IV-12, the percentage of vehicles with a component failure is higher in the non-PMVI States than the PMVI States for vehicles of all ages. Furthermore, the percentage of vehicles with a component failure increases as vehicle age increases in both non-PMVI and PMVI States. A Chi Square test of independence was performed on the data graphed in Exhibit IV-12 to compare the proportions of vehicles with a defect in the non-PMVI and PMVI States. The comparison was performed separately for each vehicle age 1 - 10 years (vehicle ages 0 and 1 were combined to compensate for the small cell sizes typical of new vehicles). Significant differences in the proportions would indicate that differences between non-PMVI and PMVI States in the number of vehicles with defects are not due to chance. The results of this analysis are presented in Exhibit IV-13. Presented are Chi Square values, associated probabilities, and an indication of the direction of differences in rates.

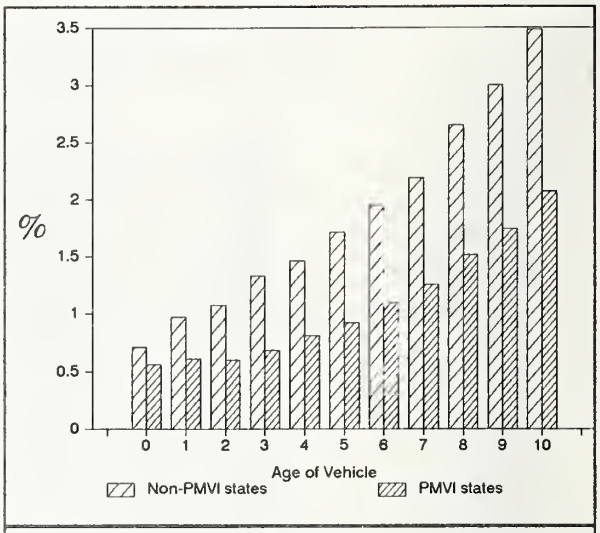

Exhibit IV-12 **CARDfile Data on Contributing Selected Component Failures for PMVI States vs Non-PMVI States**

As can be seen in Exhibit IV-13, there are significant differences between the non-PMVI and PMVI States in the proportion of vehicles with defects reported for vehicles of all ages. These significant differences indi-

Vehicle Age	Chi-Square	Probability	Direction
1	77.894	0.000	PMVI-
2	157.696	0.000	PMVI-
3	216.644	0.000	PMVI-
4	174.592	0.000	PMVI-
5	234.026	0.000	PMVI-
6	257.374	0.000	PMVI-
7	277.843	0.000	PMVI-
8	334.217	0.000	PMVI-
9	318.633	0.000	PMVI-
10	274.951	0.000	PMVI-

degrees of freedom = 1

Exhibit IV-13 **Chi Square Analysis of Vehicles With and Without Component Failure in Non-PMVI and PMVI States for Different Vehicle Ages**

cate that the proportion of vehicles with defects reported is significantly less in the PMVI States (indicated by "PMVI-" in the table) than in the non-PMVI States.

Examination of the failure data reported for individual vehicle components indicated that the higher percentage of defects reported in the non-PMVI States was due mainly to a higher percentage of reported tire failures. To determine whether there were differences between non-PMVI and PMVI States for specific types of vehicle component failures, separate Chi Square tests of independence were performed to compare the proportions of vehicles with specific types of defects in the non-PMVI and PMVI States. The comparison was performed separately for tire, brake, steering, and light defects for each vehicle age 1 - 10 years (vehicle ages 0 and 1 were again combined due to small cell sizes). Vehicles with *all other defects* reported were not analyzed since the exact type of defect reported in these cases is unknown. The results of these analyses are presented in Exhibits IV-14 to IV-17. Presented are Chi Square values, associated probabilities, and an indication of the direction of differences in rates.

There are significant differences between the non-PMVI and PMVI States in the proportion of tire, brake, and light defects reported for some vehicle ages. Tire failures differ significantly for vehicles age 2 through 10 years old (Exhibit IV-14). This finding is consistent with the Indiana Tri-level Study discussed in the literature review. The more pronounced difference in reported tire failures may be a result of tires being more easily available for inspection by an officer than brakes, steering, or lights.

Vehicle Age	Chi-Square	Probability	Direction
1	1.426	0.232	none
2	26.603	0.000	PMVI-
3	88.945	0.000	PMIV-
4	96.292	0.000	PMVI-
5	148.105	0.000	PMVI-
6	148.442	0.000	PMVI-
7	242.530	0.000	PMVI-
8	359.481	0.000	PMVI-
9	480.785	0.000	PMVI-
10	413.575	0.000	PMVI-

degrees of freedom = 1

Exhibit IV-14 **Chi Square Analysis of Tire Component Failures in Non-PMVI and PMVI States for Different Vehicle Ages**

Brake failures differ significantly for vehicles age 2 and 3 years old (Exhibit IV-15). As can be seen in Exhibit IV-16, for all vehicle ages, there is no significant difference between non-PMVI and PMVI States in the proportion of reported steering component failures.

Light failures differ significantly for vehicles age 1, 3, 5, 7, and 8 years old (Exhibit IV-17).

Vehicle Age	Chi Square	Probability	Direction
1	2.289	0.130	none
2	4.894	0.027	PMVI-
3	4.523	0.033	PMVI-
4	1.142	0.285	none
5	2.182	0.140	none
6	2.906	0.088	none
7	0.004	0.947	none
8	0.345	0.557	none
9	1.540	0.215	none
10	0.319	0.572	none

degrees of freedom = 1

Exhibit IV-15 **Chi Square Analysis of Brake Component Failures in Non-PMVI and PMVI States for Different Vehicle Ages**

Vehicle Age	Chi-Square	Probability	Direction
1	1.028	0.311	none
2	1.762	0.184	none
3	0.574	0.449	none
4	3.604	0.058	none
5	0.007	0.934	none
6	5.576	0.448	none
7	0.378	0.538	none
8	1.097	0.295	none
9	0.003	0.956	none
10	0.932	0.334	none

degrees of freedom = 1

Exhibit IV-16 **Chi Square Analysis of Steering Component Failures in Non-PMVI and PMVI States for Different Vehicle Ages**

These significant differences indicate that the proportion of vehicles with defects reported is significantly less in the PMVI States.

Vehicle Age	Chi Square	Probability	Direction
1	4.184	0.041	PMVI-
2	3.637	0.057	none
3	10.050	0.002	PMVI-
4	2.305	0.129	none
5	7.137	0.008	PMVI-
6	2.861	0.091	none
7	12.726	0.000	PMVI-
8	7.218	0.007	PMVI-
9	0.592	0.442	none
10	1.667	0.197	none

degrees of freedom = 1

Exhibit IV-17 **Chi Square Analysis of Light Component Failures in Non-PMVI and PMVI States for Different Vehicle Ages**

Although significant differences between non-PMVI and PMVI States in the number of defects reported in older vehicles suggests a possible PMVI effect, it is difficult to explain why such differences were also found in relatively new vehicles. Presumably components in vehicles only 1 or 2 years old would not have reached a condition that would be affected by the presence or absence of a PMVI program. This indicates that the differences in defects reported in relatively new vehicles between non-PMVI and PMVI States were most likely due to factors other than the presence or absence of a PMVI program. These factors may also account for the differences found in older vehicles. However, fifty (50) Chi square tests of significance were conducted in the CARDfile analysis. Twenty-six (26) resulted in differences, with all 26 test results favoring the PMVI States, none favored the non-PMVI States.

The reporting of subjective information, such as a vehicle component failure, by

police officers may introduce some bias. For example, in States with a periodic motor vehicle inspection program, it might be argued that police officers are more likely to code the failure of a component covered by the inspection program. Thus a PMVI State could have a higher reported component failure rate. Conversely, it is possible that, since a PMVI program is in place, failed vehicle components are not searched for and officers may under-report their occurrence. These subjective problems may lead to differences in coding. Police officers usually are not trained to detect component failures that are not obvious and officers rarely have the time or resources to make the type of inspections needed to accurately detect vehicle component failures. Numerous other factors may affect the coding of vehicle component failures. These factors include different criteria in coding between the States and/or jurisdictions; variance in officers' abilities to detect component failures, and severity of the crash.

Conclusions:

- Non-PMVI States reported a significantly higher percentage of old and new crash-involved vehicles with defective tires, brakes, and lights, than PMVI States. The significantly higher percentage of reported tire failures in older vehicles in non-PMVI States suggests a possible PMVI effect.

- Tire failures account for the majority of the increased percentage of component failures reported in the non-PMVI States.

- The fact that non-PMVI States reported a significantly higher percentage of component failures in relatively new cars suggests that a factor other than the presence or absence of PMVI may account for the differences in component failures reported.

Between the completion of the Interim Final Report and the submission of the docket comments under Notice 2 (and based on a study submitted by the State of Missouri) a further analysis of FARS data was conducted. Fatal crashes for the years 1985-1987 were used to compare police-reported vehicle component failures between States with PMVI programs and States without PMVI programs. The analysis revealed a pattern very similar to that described in the CARDfile analysis which appeared in the Interim Final Report. Exhibit IV-18 is a plot of PMVI and non-PMVI States showing the proportion of vehicles, by model year, involved in fatal crashes where a component failure was reported as contributing to the cause of the crash. Exhibit IV-18 shows that the proportion of vehicles with a reported defect is consistently lower in PMVI States than in non-PMVI States. Moreover, there is some tendency for this difference to be greater the older the vehicles, but this pattern is not always consistent. The largest differences between PMVI and non-PMVI States occur in vehicles which are over eight model years old.

This analysis of FARS data confirms and also extends the findings in the CARDfile analysis of the Interim Final Report. Specifically, this analysis of the FARS data confirms the finding that there are differences between PMVI and non-PMVI States in the proportion of crash-involved vehicles with reported component defects. This analysis of the FARS data extends the scope of the CARDfile analysis in that it applies to all 50 States, while the CARDfile applied to only four States. Both this and the CARDfile analysis show that, across all model years, the

proportion is consistently lower in PMVI States compared to non-PMVI States.

Conclusion:

- Analysis of FARS data for fatal crashes in all 50 States was consistent with CARDfile analysis. That is, differences between non-PMVI and PMVI States in the proportion of crashes in which a vehicle component failure was reported suggests a possible PMVI effect. However, the fact that non-PMVI States reported a significantly higher percentage of component failures in relatively new cars suggests that factors other than the presence or absence of PMVI may account for the difference in component failures reported. There still is no conclusive evidence that PMVI is, or is not, a cost-effective safety program for reducing highway crashes.

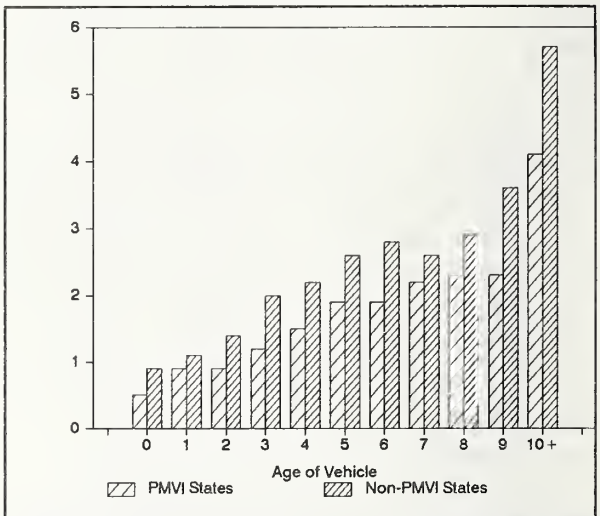

Exhibit IV-18 **FARS Data on Vehicle Component Failure Rates for PMVI vs. Non-PMVI States (Defect Rate per 100 Vehicles)**

SECTION V

SUMMARY OF PUBLIC HEARINGS AND COMMENTS TO DOCKET NO. 88-09 NOTICES 1 AND 2

A. Notice No. 1

On August 22, 1988, a notice was published in the *Federal Register* to solicit comments, and to advertise our intent to hold two public hearings on the study to evaluate the effectiveness of State motor vehicle inspection programs. The public hearings were held on September 27, 1988, in Washington, D.C. and on October 5, 1988 in Lakewood, Colorado.

We received 62 comments to the docket and heard testimony from 10 participants at the two hearings. The commenters included Directors of State Motor Vehicle Departments, Directors of Departments of Public Safety or Transportation, and Chiefs of State Highway Patrol or State Police agencies, representing 31 States and the District of Columbia.

We also received oral and written comments from national organizations such as the Coalition for Safer Cleaner Vehicles (CSCV); the Automotive Parts and Accessories Association (APAA); the Automotive Service Industry Association (ASIA); National Glass Association (NGA); Hamilton Test Systems, Inc; Systems Control, Inc; the Insurance Institute for Highway Safety (IIHS); American Trucking Association (ATA); American Association of Motor Vehicle Administrators (AAMVA); Automobile Club of Southern California; American Automobile Association (AAA); National Automobile Dealers Association, (NADA); the Motor Vehicle Manufacturers Association (MVMA); and the Center for Auto Safety. In addition, we received comments from Ford Motor Company, Chrysler Motors Corporation, and other interested individuals.

These comments are summarized below by the issues identified in the *Federal Register* notice.

1. General Comments

Most commenters support PMVI as an effective program that reduces deaths injuries and crashes. A small number of non-PMVI States oppose periodic motor vehicle inspection, but they support random or spot inspections as a highway safety countermeasure. These non-PMVI States also support random inspection of commercial vehicles, and periodic inspections of school buses.

Several respondents pointed out that vehicle owners are keeping their vehicles longer. As vehicles become older and wear out, they become unsafe without continuing inspection and maintenance practices.

A number of commenters believe the Federal Government should update the VIU standards and the Highway Safety Program Manual to account for new technology in motor vehicles such as the anti-lock braking system, four-wheel steering, on-board diagnostics, etc. They believe these standards would assist the States in developing procedures for inspecting the current vehicles that have incorporated technological improvements.

In addition, they suggested that a collateral Federal role is to review and amend the existing Federal Motor Vehicle Safety Standards (FMVSS) to include on-board diagnostics to provide improved *inspectability* of safety components, such as the thickness of brake friction materials without requiring disassembly of the brake system.

While most commenters do not believe PMVI should be Federally mandated, they

advocated Federal guidance to help the States strengthen their programs. A small number urged that a combination of Federal sanctions and incentives would be effective in achieving uniform PMVI programs.

2. Federal Register Issues

To assist in commenting to the Federal Register notice, NHTSA included a list of issues to be addressed. While other issues could have been addressed, no comments on other issues were received.

Issue No. 1: Information on cost-effectiveness of benefits and costs of vehicle inspections.

Most commenters believe that PMVI produces more benefits compared to costs. Several PMVI States cited very general crash data showing reductions in crashes, injuries and fatalities and after PMVI was introduced. These States also cited data which showed reductions in mechanical failures causing or contributing to crashes over time. Some respondents stated the logic of inspection: vehicle failures cause crashes, inspection detects failures, therefore, inspection reduces crashes. Several refer to the benefit-cost study of PMVI in the State of New Jersey, entitled *CAMVIS, Comprehensive Analysis of the Motor Vehicle Inspection System*, dated August 1982. This study involved a time-series regression analysis of New Jersey fatalities, injuries, total crashes and death rates for 100,000,000 miles travelled from 1929-1979. The authors estimated that inspection saved at least 314 lives annually in New Jersey. Total costs were estimated at about 83 million dollars. The authors found a benefit-cost ratio of at least 1.85 to 1 for PMVI in New Jersey.

Peter D. Loeb, Associate Professor of Economics, has conducted research in this area in New Jersey. He testified that his research has established empirical evidence that motor vehicle inspection has a significant negative effect on automobile fatality rates, and that motor vehicle inspection appears to be cost-effective in New Jersey.

Several PMVI States point out that 25-38 percent of vehicles are rejected for vehicle failures, which suggests the effectiveness of PMVI. One commenter stated that 45 million crash-damaged vehicles are returned to the highways without safety or emissions inspections, and that the NHTSA Heavy Truck Safety Study shows that:

> "*...brake system performance could be involved as a contributing factor in as many as one-third of all truck accidents.*"

The Illinois Department of Transportation submitted a paper which compares general crash trends of single vehicle crashes of pickup trucks, and vans, before and after they were removed from the semi-annual safety inspection program in 1984. A comparison of the data for the two periods of 1984 revealed almost a 25 percent increase in the daily number of crashes of pickup trucks and vans. Further, before and after comparative analyses show increases in injuries and property damage.

A few of the non-PMVI States stated that according to their crash records, defective equipment was identified as a contributing factor in less than two percent of crashes; therefore, the cost of PMVI is not justified.

Other respondents believe that a benefits determination cannot be done by correlating current programs with fatality and crash

rates. Only a properly designed study by an independent organization can resolve the matter. Data linking mechanical failures and crashes are difficult to obtain because law enforcement personnel are not mechanics, and their first concern at a crash scene is care of the injured, and clearing the site of hazards. One commenter indicated that traditional cost-benefit models are inappropriate from a public health and safety perspective. No other regulatory activity directed at reducing a toll of 46,000 deaths per year is held to such a standard, in which the value of benefits should exceed costs.

The Insurance Institute for Highway Safety comments that there is no conclusive evidence that motor vehicle inspection is effective or ineffective in reducing crashes. Reducing the number of defective vehicles is not likely to have a large effect on the total number of crashes. To judge the true effect of motor vehicle inspection programs, a research project would have to be conducted which would identify safety-related vehicle deficiencies that would be corrected as a result of the inspection process. Crashes affected by those deficiencies would be examined to determine whether the inspection program would have reduced the frequencies of the crashes.

Issue No. 2: Are any additional and more current data available regarding the issue of involvement of vehicle mechanical failures in crashes? Is this issue serious enough to warrant renewed emphasis establishing and improving motor vehicle inspection programs? Who should take the lead role?

Several PMVI States responded to the issue of involvement of vehicle mechanical failures in crashes by citing numbers and percentages of component failures detected through inspection. For example, Texas states that in 1987, over 260,000 vehicles were rejected for brake failures, Missouri states that it rejects annually almost 21.6 percent of vehicles inspected, and Virginia indicates that the percent of defective vehicles increased from 21.6 percent in 1982 to 34 percent in 1986.

Most of the comments were directed toward the issues of renewed emphasis of PMVI and State and Federal roles. Most commenters believe NHTSA is the logical entity to establish minimum guidelines to assure nationwide uniformity, and that NHTSA should renew emphasis in establishing and improving PMVI programs. Virginia believes its experience exemplifies the need for renewed emphasis and that the individual States should take the lead role. Missouri believes the States, NHTSA, a renewed Vehicle Equipment Safety Commission and the American Association of Motor Vehicle Administrators should be involved to encourage uniformity of procedures and guidelines.

The Motor Vehicle Manufacturers Association (MVMA) comments that it supports motor vehicle inspection by publishing the Vehicle Inspection Handbook for passenger cars, and for trucks, buses and school buses in cooperation with the American Association of Motor Vehicle Administrators. The handbooks which are updated annually, provide States with appropriate testing methods for vehicle subsystems and are the foundation for most State inspection programs. MVMA recommends NHTSA adopt its handbooks.

Issue No. 3: Should the movement of vehicles between States be a sufficient reason for all States to have PMVI laws? How should this result be encouraged?

Most respondents recognize that vehicle movement is national in scope due to our mobile and transient society. Oklahoma reports that:

> "*Eighteen percent of all vehicles registered in Oklahoma in 1987 were transient from other States. Nationwide criteria and uniform PMVI programs would create less confusion for the vehicle owners as they move from State to State.*"

Several States support NHTSA issuance of uniform standards, but they do not support a Federally mandated program.

Issue No. 4: Is there information on the accurate detection of faulty vehicle components before they cause or contribute to a possible crash?

Few commenters addressed this issue. One states that faulty vehicle components are difficult to detect even for the most experienced inspectors. Contributing factors such as metal stress contribute to the difficulty of detection. Virginia states that the key in controlling undetected or uncorrected failures lies with proper training of inspectors and managers, coupled with enforcement activities and random roadside inspections. Other commenters state that information is not available on the detection of faulty components.

The Coalition for Safer Cleaner Vehicles (CSCV) states that it is widely recognized that existing State vehicle safety inspections are limited in their ability to examine brake systems effectively. This points to the need for enhancing *inspectability* of such critical safety components through issuance of Federal Motor Vehicle Safety Standards and improving inspection methodology and equipment. Automated equipment is available, such as computer controlled dynamometers which test brake capacity under loaded conditions.

Issue No. 5: Comparisons between various types of inspection programs in reducing crashes. Is it possible to inspect vehicles only after a certain number of miles and/or age?

The commenters indicate that comparisons of vehicle related crashes between PMVI, non-PMVI and random inspections States would be difficult. The data are neither reliable nor accurate because police officers are not adequately trained to recognize equipment failures and it is difficult to determine the contribution of vehicle component failure to a crash.

Further, the respondents indicate that older vehicles may require a higher frequency of inspection than newer ones. However, much depends on a particular owner's driving habits and maintenance practices and that it may not be possible to discriminate among vehicles based on age or mileage. Also, such a system would be administratively unworkable.

Issue No. 6: Information on the cost and benefits of combining emissions and safety inspection.

Respondents on this issue support combining emissions and safety inspections because it is logical, cost-effective and convenient to the motorist. Vehicle owners are more satisfied to present their vehicles once for both inspections rather than twice for separate inspections. A commenter from New York noted that after repeal of the PMVI law in his State, law enforcement paid little attention to enforcing emission requirements. In New York emissions and safety inspections are combined in the New York metropolitan

area, and the data for both inspections are collected electronically. In the early 1970's, however, Hawaii found that it was difficult to manage both safety and emissions inspections at the same facility at the same time. (Hawaii no longer conducts emissions testing).

As expressed at one of the hearings, the Colorado experience in implementing an emissions inspection program could parallel and lend support to the reinstatement and implementation of a safety inspection program. Colorado no longer has a safety inspection, due to the repeal of their PMVI law in 1981.

The Coalition for Safety Cleaner Vehicles (CSCV) indicates that in a centralized emissions inspection system, vehicle owners are already being required to take their vehicles in for one inspection, the physical plant is set up and the site is already in place. Provided that the existing buildings and sites are large enough to accommodate additional test equipment and marginally longer lines, a strong case exists for combining both programs. If the necessary inspection equipment cannot be fitted into the existing facilities for combining safety and emissions, facilities would have to be built.

Issue No. 7: Guidelines and procedures that would be practical and not costly for inspecting motor vehicles including the braking system.

The commenters that address this issue, for the most part, confine their comments to the braking system. One respondent states that a platform type brake tester should be required in inspecting brakes, and one front and rear wheel should be removed to inspect lining thickness. Missouri believes removing the one wheel to inspect internal brake components is workable but a better method for testing brake performance should be pursued.

The CSCV comments that the current vehicle population does not lend itself to quick or easy inspection. Some safety-critical components are needlessly difficult to reach and measure, which is the reason Congress required the issuance of vehicle-in-use standards. The CSCV further states that the answer is not more costly and more sophisticated test equipment, nor is it a requirement to remove wheels and disassemble the braking system. The simple answer is to require friction material wear-warning indicators as part of the braking system and its replacement parts, as some manufacturers are already doing.

Issue No 8: Effectiveness and costs of random or spot inspection programs in comparison to PMVI programs.

Most commenters responding to this issue oppose the use of random or spot inspections as an alternative to PMVI. Typically, these commenters state that annual inspections of all vehicles, at a fixed facility, allows for a thorough inspection of the vital systems and components of a motor vehicle. Oklahoma states that:

> "*...we utilize random or spot inspections to check for compliance to our Inspection Program. We contend random or spot inspections alone are inefficient due to the number of man-hours involved, the small percentage of vehicles checked and the overall effectiveness.*"

The State of Ohio, which has a random inspection program, supports random or spot inspection because it believes this type of program provides an effective deterrent to

those who drive defective vehicles. Comments from random or spot inspection States other than Ohio, state that vehicle safety equipment requirements are enforced during traffic patrol and enforcement duties. To support the view that random inspection is more effective than PMVI, four random or spot inspection States cite data from the crash records showing a small percentage of vehicle with mechanical failures causing or contributing to crashes.

Issue No. 9: How might technological improvements affect the frequency of PMVI as well as the procedures and equipment needed for inspection?

The respondents recognize that vehicles are now generally safer due to technological advances of the past. Most commenters recognize that technological improvements should also be part of the inspection process. Also, systems such as on-board diagnostics should have the capability of uniform hardware connectors for periodic testing and evaluation. New systems such as anti-lock braking, airbags, four-wheel steering, etc., may require more sophisticated testing equipment and procedures. A number of commenters indicate that NHTSA has a responsibility to issue vehicle-in-use inspection standards, and that these standards should incorporate diagnostic inspection pass/fail criteria for the appropriate vehicle systems.

Missouri's comments are typical of those from other States. Missouri states that:

> "*...these technological improvements should become part of the safety inspection process. For example, on-board diagnostics could be monitored during the inspection process by a computer at either a centralized or decentralized inspection facility. We feel that an upgraded system of inspection will improve the quality of inspections and result in less inconvenience to motorists.*"

The repeal of Colorado's PMVI law was triggered largely by unfavorable publicity about the inconsistency of inspection procedures. State officials felt that computerized inspection procedures would assure consistency, and would provide confidence to the public in the results of the inspection. With the availability of new technology, much subjectivity would be removed from the present inspection process and the Colorado legislature might consider the reinstatement of PMVI.

The use of technologically improved inspection equipment and procedures was illustrated by the showing of a video tape at the public hearing in Washington, D.C. Mr. Tom Collier of Hamilton Test Systems, Inc. showed the tape, which portrayed the use of an automated, computerized safety inspection lane to inspect public and private school buses in a pilot project conducted in Dade County, Florida. For non-visual tests, automated and computerized equipment was used specifically to: (1) track the identification of the vehicle, (2) test for emissions with the use of a dynomometer as a precondition to the test, (3) test for headlight aiming and light intensity (4) measure front-end alignment, and (5) test brakes with computerized dynamic equipment. The same technology is being used to inspect passenger vehicles, and the process is being demonstrated in Connecticut. The computer makes the pass/fail decisions. For visual tests, the inspector enters the pass/fail code in the computer.

Issue No. 10: Feasibility of providing for PMVI as a part of the warranty program.

Commenters on this issue uniformly oppose the inclusion of PMVI under the vehicle manufacturer's warranty program. The comments state that mandated warranties would be anticompetitive for the aftermarket by giving vehicle manufacturers a monopoly over vehicle inspection, to be performed by franchised dealers. There would be no checks and no independent aftermarket, and the public would be potentially subjected to greater inconvenience and higher costs. This would occur because vehicle manufacturers would have to recover not only the inspection costs, but also the administrative costs incurred in handling the program.

Ford Motor Company states that they do not believe that PMVI and warranty programs can be combined because they are separate and distinct functions. PMVI is a periodic event to assure that vehicles are maintained, while warranty programs provide customer satisfaction in the event a vehicle defect or malfunction occurs during the warranty period, which events may occur randomly.

Also, Ford does not believe that PMVI could be successfully integrated into a manufacturer's recommended maintenance schedule. Little maintenance is required until 30,000 miles have been accumulated on the vehicle. After that point has been reached, scheduled maintenance intervals are variable. This would make it very difficult to administer vehicle inspection requirements as part of a manufacturer's recommended maintenance schedule.

Oklahoma and other States note that older vehicles have the most failures, there would be enforcement difficulties, and the additional costs would be passed on to the consumer in inflated vehicle purchase prices.

In conclusion, hearings and comments to the docket reflect support for PMVI programs, even though it is admittedly difficult to prove effectiveness on a benefit-cost basis. PMVI does detect vehicle component failures, but the detection of such failures in a crash situation is difficult. Comments from States conducting both safety and emission inspections favor combining emissions and safety inspections as being cost-effective and convenient to the motorist. Most suggest that technological improvements should be a part of the inspection process. All commenters addressing this issue oppose the inclusion of PMVI under the vehicle manufacturers warranty program.

In both the hearings and the docket comments respondents urge the Federal Government to provide guidance and assistance on the latest technological developments and practices in PMVI. However, most agree that PMVI should not be Federally mandated.

B. Notice No. 2

On May 9, 1989, a notice was published in the *Federal Resigter* to announce the completion of the Interim Final Report on the effectiveness of State periodic motor vehicle inspection programs, and to request comments on this Report.

Thirteen organizations submitted comments to the docket. State agencies commenting included State Highway Patrols, State Departments of Transportation and State Departments of Public Safety, representing seven States.

National organizations commenting were the American Automobile Association (AAA), National Automobile Dealers Association (NADA), Automobile Club of

Southern California, and the Coalition for Safer, Cleaner Vehicles (CSCV). In addition, we received comments from Ford Motor Company and the State University of New Jersey, Rutgers.

In general, State comments supported the Study. Wisconsin has a random inspection program and has no plans to implement a periodic program. Colorado is not likely to consider reinstating a PMVI program at this time, since the Study finds no strong correlation between crash reduction and PMVI. For the same reason, the Washington State Patrol does not support mandatory PMVI programs, and feels that other traffic law enforcement programs are more cost-beneficial. Nevada does not feel that PMVI would be effective in reducing highway accidents, and thus believes that PMVI should not be federally mandated. However, any guidelines regarding vehicle safety inspections developed by the Federal Government to strengthen existing inspection programs would be appreciated. In commenting on the NHTSA Data Analysis, Section IV, Illinois suggested that data on tire failures would be more definitive if they could be categorized by type of failure.

While having no problems with the interim report, Virginia reiterated its position that, over the years, their periodic motor vehicle inspection is effective in reducing highway crashes caused by vehicle component failures. Also, they believe that their program assures better maintained and mechanically safer vehicles than found in States with no periodic motor vehicle inspection. Additionally, Virginia recommends that NHTSA should consider mandating universal plugs or devices on the vehicle that can be accessed by inspector/mechanics to inspect safety components.

In Missouri's comments, it was pointed out that the report is a review of old information and only Section IV on NHTSA Data Analysis is new research. They were somewhat disappointed that additional new research was not conducted.

With their comments, Missouri submitted a copy of a study they conducted for their PMVI program, using data from the NHTSA FARS file. Their findings paralleled those of NHTSA in Section IV of the Study using the Crash Avoidance Research Data file (CARDfile). Essentially, Missouri found that newer vehicles have proportionally fewer vehicle defect causation factors than do older vehicles involved in fatal crashes. In addition, those vehicles registered in States having motor vehicle inspection programs had proportionately fewer defects as causative factors than States not having such programs.

In the comments from national associations, the AAA felt that the NHTSA Study failed to provide the comprehensive evaluation called for in P. L. 100-202, recognizing this was due to excessive cost considerations. The AAA maintains its position that State motor vehicle inspection programs definitely should not be the subject of a federal mandate. The AAA urged NHTSA to consider alternatives or modifications to mandatory PMVI, including change of ownership safety inspections, biennial inspections, and active random roadside inspections. Safety inspection programs should be left to the prerogative of each individual State, and the AAA encouraged NHTSA to continue investigating solutions to the many problems associated with PMVI.

The Automobile Club of Southern California was not surprised that the Study found current State PMVI programs not effective

in reducing highway accident fatality rates. The were pleased that NHTSA realizes the potential for accident reduction due to vehicle system failures, and trust that the findings will allow NHTSA to move rapidly to apply on-board diagnostics system monitoring of critical vehicle safety systems.

In two separate comments, NADA felt that the findings and conclusions of the report appear to reflect consideration of those issues raised in previous NADA comments. NADA supports comprehensive, State administered, cost-effective, periodic safety inspections utilizing authorized private vehicle maintenance facilities. In a later comment, NADA went on record in general support of the analysis submitted by the Coalition for Safer, Cleaner Vehicles (discussed below).

The comments from the Coalition for Safer, Cleaner Vehicles (CSCV) generally reflect disagreement with the Study findings, since, according to CSCV, available data conclusively establishes the contribution of vehicle safety defects to crashes and the ability of effective PMVI programs to detect and require correction or repair of such defects. CSCV's position is that the positive cost-benefit ratio of PMVI has been demonstrated in a number of the previous comments to the docket on the effectiveness of PMVI. If NHTSA believes there is a lack of credible data on the potential value of PMVI, CSCV felt that NHTSA should recommend an independent, objective study of PMVI and its benefits, including the proposal of such pilot or demonstration programs as may be appropriate.

Further, CSCV felt that the report is not based upon scientific studies of vehicle defects and their possible implication in crashes, since the report relies almost exclusively upon two types of databases, FARS and CARDfile, derived from police accident reports which they argue are unreliable. Further, CSCV points out that neither of these databases was designed to study vehicle defects or their possible implication as causing or contributing to crashes.

In addition, CSCV feels that NHTSA's review of the PMVI literature is biased, since it is primarily based on the NHTSA report, *Cost-effectiveness of Periodic Motor Vehicle Inspection (PMVI): A Review of the Literature*, which they believe is slanted to finding the lack of proof of positive cost/benefits of PMVI. Moreover, CSCV felt that the cost-benefit computation of this cost-effectiveness report is based solely upon the economic benefits of reducing general accident rates and avoiding injury, and assigns no value to the contribution that the report recognized PMVI makes to:

> "*...improving the general condition of vehicles and perhaps also in improving the quality of repairs carried out by the automotive repair industry.*"

Finally, CSCV stated that the Study lacks analysis of current new high-technology inspection systems, and instead, focuses upon deficiencies of past PMVI programs that have been repealed, or existing PMVI programs that have been little changed since the Safety Acts were enacted in 1966. They believe that neither sophisticated PMVI testing nor the need to facilitate access to on-board diagnostic data has been considered, although NHTSA has the statutory authority to impose vehicle connectibility standards.

The Ford Motor Company offered no specific comments on the report, except to commend the agency on the comprehensive

manner in which the various PMVI issues have been covered in the Study.

The comments from the State University of New Jersey, Rutgers indicated that the debate regarding the effectiveness of PMVI will most likely continue until some accepted body of research provides conclusive evidence one way or another. Other econometric models not included in the bibliography of the report were referenced. However, the papers on these models were made available at the PMVI Study hearing in Washington, D. C. on September 27, 1988. More recent research was mentioned which, as contended by the Rutger's commenter, provides statistical evidence supportive of motor vehicle inspection.

In conclusion, the docket coments to the Interim Final Report did not introduce new evidence that would cause changes in the Report. Those States and organizations supporting PMVI reiterated this support in their comments, especially those from the Coalition for Safer, Cleaner Vehicles (CSCV). Although CSCV criticized the Interim Final Report, particularly in their desire to see more scientific research conducted and the use of improved data, the Report was prepared utilizing available resources of research, crash and vehicle component failure data. Any additional research or study, as suggested by CSCV, would be significantly beyond the scope, available resources and time frame established in the Study plan.

SECTION VI

FINDINGS AND CONCLUSIONS

• Currently 21 States and the District of Columbia have PMVI programs. An additional 16 States require an annual inspection of school buses. Nineteen of the 29 non-PMVI States carry out spot or random inspection of passenger vehicles. Fourteen PMVI States and the District of Columbia, and 18 non-PMVI States inspect for vehicle emissions. For the PMVI States there is considerable variation in the equipment items inspected, and the procedures, rules and regulations for inspections.

The American National Standard Institute (ANSI) originally developed and issued inspection standards and procedures, with the latest revision issued in 1973. NHTSA endorsed these standards and procedures as provided in the NHTSA Highway Safety Guideline No. 1, Periodic Motor Vehicle Inspection. In 1973, NHTSA modified its endorsement with the issuance of its Vehicle-In-Use Inspection Standards. However, NHTSA has not revised nor issued further PMVI materials since these VIU Standards of 1973. In 1978, the American Association of Motor Vehicle Administrators (AAMVA) issued recommended guidelines for the inspection of vehicle systems and components. The Motor Vehicle Manufacturers Association (MVMA), in cooperation with AAMVA, publishes Vehicle Inspection Handbooks, with updates issued on an annual basis.

Most commenters to the docket and in the public hearings expressed the desirability of receiving guidance from the Federal level on PMVI to help strengthen State programs. At the same time, they said that PMVI should not be Federally mandated as in the past. Regarding Federal funding for PMVI, there was no strong sentiment in the comments for direct support to the States, since the program is generally self-sustaining through inspection fees.

• Nineteen of 22 PMVI States have chosen the State Licensed and Appointed system as the preferred way to implement a mandatory motor vehicle inspection program. The factors of lower cost and less inconvenience played a large part in the State decisions to choose this type of system.

There is considerable evidence in the literature that PMVI programs are far from being as effective improving vehicle safety conditions as would be desirable. Many areas which have PMVI do not require inspection of all important safety components, and many licensed inspection stations do not conduct proper inspections of all the components they are required by law to inspect. In addition, there is evidence that frequently, repairs of inspected components which were found to be defective were not properly made.

As expressed in the docket comments and in hearing testimony, the public generally favors and has confidence in a well conducted PMVI program, not only related to safety, but as a means of keeping down long-term maintenance costs.

• From the comments to the docket and testimony at the public hearings, the importance of technological improvements is strongly evident. In addition to technology in the inspection facilities, the commenters also suggested that Federal Motor Vehicle Safety Standards (FMVSS) should be reviewed and amended to include on-board diagnostic technology to improve the quality of inspection of safety components. Missouri's comment is typical of those from other States, indicating that technological improvements should be a part of the inspec-

tion process, including the monitoring of on-board diagnostics; and such an upgraded system would improve the quality of inspections, with less motorist inconvenience. Colorado stated that computerized procedures would assure consistency and provide confidence to the public on inspection results, removing much of the subjectivity from the current inspection process.

In the Washington, D.C. public hearing, a pilot school bus computerized inspection system in Florida was shown on video tape, illustrating the availability and use of new technology. The same type of system could be used to inspect passenger vehicles, and is being demonstrated in Connecticut. Some of the European countries, as well as other foreign countries are also investigating and using advanced equipment for inspection.

- Fourteen PMVI States and the District of Columbia also inspect for emissions in designated non-attainment air quality areas identified by the Environmental Protection Agency. Eighteen other States inspect only for emissions in designated non-attainment and quality areas. Where both type inspections are conducted, most PMVI States combine safety and emission inspections.

New Jersey combined safety and emission inspections in 1973 and found such a system cost-effective. In addition to motorist convenience, the combination inspection avoids the need to maintain more than one level of supervision. In responding to the docket, all commenters support combining emission and safety inspections because it is logical, cost-effective and convenient to the motorist. Colorado indicates that its experience in implementing an emission inspection could parallel and lend support to the reinstatement and implementation of a safety inspection program.

- In the review of the literature, most studies of inspected and uninspected vehicles found a correlation between better vehicle condition and the presence of an inspection program. However, most of the literature concluded that reliability or effectiveness of the PMVI process in detecting and correcting vehicle component failures is generally poor. In determining changes in vehicle component related crashes with PMVI, previous researchers questioned the ability to evaluate PMVI effectiveness by looking at vehicle-defect crash rates. This is due largely to the small proportion of vehicle-defect crashes found in crash investigations. Considering reduction in crashes as a result of PMVI, the studies in the literature are generally inconclusive and unreliable, either due to the lack of credible data, or due to weaknesses in the study design. Some studies show a positive effect as a result of PMVI, others no effect, and in some instances, a negative effect was shown.

Considering cost-effectiveness of PMVI, none of the reviewed studies provide credible evidence that current PMVI programs are cost-effective. This is mainly because there is a shortage of convincing research on the effectiveness of PMVI in reducing vehicle-defect related crashes.

- NHTSA analysis of the Fatal Accident Records System (FARS) data and State crash data files failed to show any evidence in the crash data examined which would suggest that PMVI programs affect the crash involvement rates of older vehicles compared to newer vehicles. The fatal crash involvement rate of older vehicles compared to new vehicles was not significantly different between PMVI and non-PMVI

States. State data files in total crash involvement did not indicate a difference between the crash involvement rate by model year, PMVI compared to non-PMVI States.

In addition to the crash involvement rate analysis, data from the Crash Avoidance Research Data file (CARDfile) were analyzed. The CARDfile analysis suggests that PMVI has a small positive impact. In the CARDfile analysis non-PMVI States reported a significantly higher percentage of old and new crash involved vehicles with defective tires, brakes, and lights than PMVI States. In a further analysis of FARS data, the contribution of vehicle component failures to crashes confirmed the findings in the CARDfile analysis. These findings are consistent with the Indiana Tri-level Study. Tire failures accounted for the majority of the increased percentage of component failures reported in the non-PMVI States.

As indicated in the literature review, NHTSA analysis of various data files, comments to the docket and public hearings, the task force found no conclusive evidence that PMVI is or is not effective in reducing highway crashes. The literature review and comments to the docket revealed that PMVI was effective in limiting the number of poorly maintained vehicles on the highways. Our attempts to correlate this with a reduction in crashes on the highways failed to show any significant effect of PMVI. The analyses of the FARS and State Crash data did not show crash reduction results benefits in PMVI States. The CARDfile analysis did show benefits for PMVI in terms of vehicle component failures, but the benefits were so small (a maximum 1.5% reduction, for older vehicles) as to not have much practical significance. While the accident data files that currently exist (FARS, State Crash Data and CARDfile) have limitations, they and, particularly the CARDfile, can be used to assess some of the effects of PMVI on crash frequency.

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APPENDIX A

Glossary

Glossary

Cost Benefit - A method of analyzing and measuring the cost of a program compared to a measure of expected benefits.

Cost-Effectiveness - A method of analyzing and comparing the cost of alternative systems for achieving agreed upon goals.

Diagnostic Inspection - A method of testing, checking and analyzing safety and performance systems of a motor vehicle with the most sophisticated equipment available.

Failure - An out-of-specification condition in at least one aspect of the criteria of a vehicle system or component established by the States in their PMVI programs.

Outage Rate - A comparison of the condition of vehicles based on the total number of vehicle component failures divided by the total number of component tests.

Random Inspection - A system of selection of motor vehicles, based on probability of occurrence, from the traffic stream by authorized representatives of a State to conduct a test or check of vehicle safety systems or components in accordance with State established inspection standards and procedures.

Trial Substitute Motor Vehicle Inspection Program - An opportunity for a State to conduct an experimental, pilot or demonstration program, using acceptable inspection standards and procedures and an evaluation design.

APPENDIX B

Vehicle-In-Use Inspection Standards

PART 570—VEHICLE IN USE INSPECTION STANDARDS

Subpart A—Vehicles with GVWR of 10,000 Pounds or Less

(Docket No. 73–9)

Composite of Notices 1, 2, 4, 5, 6

Subpart A—Vehicles With GVWR of 10,000 Pounds or Less

570.1 Scope

570.2 Purpose

570.3 Applicability

570.4 Definitions

570.5 Service brake system

570.6 Brake power unit

570.7 Steering systems

570.8 Suspension systems

570.9 Tires

570.10 Wheel assemblies

AUTHORITY: Secs. 103, 108, 119, Public Law 89–563, 80 Stat. 718, 15 U.S.C. 1392, 1397, 1407; delegation of authority at 49 CFR 1.51.

§ 570.1 Scope. This part specifies standards and procedures for inspection of hydraulic service brake systems, steering and suspension systems, and tire and wheel assemblies of motor vehicles in use.

§ 570.2 Purpose. The purpose of this part is to establish criteria for the inspection of motor vehicles by State inspection systems, in order to reduce death and injuries attributable to failure or inadequate performance of motor vehicle systems.

§ 570.3 Applicability. This part does not in itself impose requirements on any person. It is intended to be implemented by States through the highway safety program standards issued under the Highway Safety Act (23 U.S.C. 402) with respect to inspection of motor vehicles with gross vehicle weight rating of 10,000 pounds or less, except motorcycles or trailers.

§ 570.4 Definitions. Unless otherwise indicated, all terms used in this part that are defined in 49 CFR Part 571, Motor Vehicle Safety Standards, are used as defined in that part.

§ 570.5 Service brake system. [Unless otherwise noted, the force to be applied during inspection procedures to power-assisted and full-power brake systems is 25 lb, and to all other systems, 50 lb. (39 F.R. 12867—April 9, 1974. Effective: 5/9/74)]

(a) *Failure indicator.* The brake system failure indicator lamp, if part of a vehicle's original equipment, shall be operable. (This lamp is required by Federal Motor Vehicle Safety Standard No. 105, 49 CFR 571.105, on every new passenger car manufactured on or after January 1, 1968, and on other types of motor vehicles manufactured on or after September 1, 1975.)

Inspection procedure. Apply the parking brake and turn the ignition to start, or verify lamp operation by other means indicated by the vehicle manufacturer that the brake system failure indicator lamp is operable.

(b) *Brake system integrity.* The brake system shall demonstrate integrity as indicated by no perceptible decrease in pedal height under a 125 pound force applied to the brake pedal or by no illumination of the brake system failure indicator lamp. The brake system shall withstand the application of force to the pedal without failure of any line or other part.

Inspection procedure. With the engine running on vehicles equipped with power brake systems, and the ignition turned to "on" in other vehicles, apply a force of 125 pounds to the brake pedal and hold for 10 seconds. Note any decrease in pedal height, and whether the lamp illuminates.

(c) *Brake pedal reserve.* When the brake pedal is fully depressed, the distance that the pedal has traveled from its free position shall

be not greater than 80 percent of the total distance from its free position to the floorboard or other object that restricts pedal travel.

Inspection procedure. Measure the distance (A) from the free pedal position to the floorboard or other object that restricts brake pedal travel. Depress the brake pedal, and with the force applied measure the distance (B) from the depressed pedal position to the floorboard or other object that restricts pedal travel. Determine the percentage as $\frac{A-B}{A} \times 100$. The engine must be operating when power-assisted brakes are checked. The pedal reserve check is not required for vehicles equipped with full-power (central hydraulic) brake systems, or to vehicles with brake systems designed to operate with greater than 80 percent pedal travel.

(d) *Service brake performance.* Compliance with one of the following performance criteria will satisfy the requirements of this section. Verify that tire inflation pressure is within the limits recommended by vehicle manufacturer before conducting either of the following tests.

(1) *Roller-type or drive-on platform tests.* The force applied by the brake on a front wheel or a rear wheel shall not differ by more than 20 percent from the force applied by the brake on the other front wheel or the other rear wheel respectively.

Inspection procedure. The vehicle shall be tested on a drive-on platform, or a roller-type brake analyzer with the capability of measuring equalization. The test shall be conducted in accordance with the test equipment manufacturer's specifications. Note the left to right brake force variance.

(2) *Road test.* The service brake system shall stop the vehicle in a distance of 25 feet or less from a speed of 20 miles per hour without leaving a 12-foot-wide lane.

Inspection procedure. The road test shall be conducted on a level (not to exceed plus or minus one percent grade) dry, smooth, hard-surfaced road that is free from loose material, oil or grease. The service brakes shall be applied at a vehicle speed of 20 miles per hour and the vehicle shall be brought to a stop as specified. Measure the distance required to stop.

(e) *Brake hoses and Assemblies.* [Brake hoses shall not be mounted so as to contact the vehicle body or chassis. Hoses shall not be cracked, chafed, or flattened. Protective devices, such as "rub rings," shall not be considered part of the hose or tubing. (39 F.R. 12867—April 9, 1974. Effective: 5/9/74)]

Inspection procedure. Examine visually, inspecting front brake hoses through all wheel positions from full left to full right for conditions indicated.

[Note: to inspect for (f), (g), and (h) below, remove at a minimum one front wheel and one rear wheel.]

(f) *Disc and drum condition.* If the drum is embossed with a maximum safe diameter dimension or the rotor is embossed with a minimum safety thickness dimension, the drum or disc shall be within the appropriate specifications. These dimensions will be found on motor vehicles manufactured since January 1, 1971, and may be found on vehicles manufactured for several years prior to that time. If the drums and discs are not embossed the drums and discs shall be within the manufacturer's specifications.

Inspection procedure. Examine visually for condition indicated, measuring as necessary.

(g) *Friction materials.* On each brake the thickness of the lining or pad shall not be less than one thirty-second of an inch over the rivet heads, or the brake shoe on bonded linings or pads. Brake linings and pads shall not have cracks or breaks that extend to rivet holes except minor cracks that do not impair attachment. Drum brake linings shall be securely attached to brake shoes. Disc brake pads shall be securely attached to shoe plates.

Inspection procedure. Examine visually for conditions indicated, and measure height of rubbing surface of lining over rivet heads. Measure bonded lining thickness over shoe surface at the thinnest point on the lining or pad.

(h) *Structural and mechanical parts.* Backing plates and caliper assemblies shall not be deformed or cracked. System parts shall not be broken, misaligned, missing, binding, or show evidence of severe wear. Automatic adjusters and other parts shall be assembled and installed correctly.

Inspection procedure. Examine visually for conditions indicated.

§ 570.6 Brake power unit. Vacuum hoses shall not be collapsed, abraded, broken, improperly mounted or audibly leaking. With residual vacuum exhausted and a constant 25 pound force on the brake pedal, the pedal shall fall slightly when the engine is started, demonstrating integrity of the power assist system. This test is not applicable to vehicles equipped with full power brake system as the service brake performance test shall be considered adequate test of system performance.

Inspection procedure. With engine running, examine hose visually and aurally for conditions indicated. Stop engine and apply service brakes several times to destroy vacuum in system. Depress brake pedal with 25 pounds of force and while maintaining that force, start the engine. If brake pedal does not fall slightly under force when the engine starts, there is a malfunction in the power assist system.

§ 570.7 Steering systems.

(a) *System play.* Lash or free play in the steering system shall not exceed values shown in Table 1.

Inspection procedure. With the engine on and the wheels in the straight ahead position, turn the steering wheel in one direction until there is a perceptible movement of a front wheel. If a point on the steering wheel rim moves more than the value shown in Table 1 before perceptible return movement of the wheel under observation, there is excessive lash or free play in the steering system.

TABLE 1.—Steering System Free Play Values

Steering Wheel Diameter (In.)	*Lash (In.)*
16 or less	2
18	2¼
20	2½
22	2¾

(b) *Linkage play.* Free play in the steering linkage shall not exceed one-quarter of an inch.

Inspection procedure. Elevate the front end of the vehicle to load the ball joints. Insure that wheel bearings are correctly adjusted. Grasp the front and rear of a tire and attempt to turn the tire and wheel assembly left and right. If the free movement at the front or rear tread of the tire exceeds one-quarter inch there is excessive steering linkage play.

(c) *Free turning.* Steering wheels shall turn freely through the limit of travel in both directions.

Inspection procedure. Turn the steering wheel through the limit of travel in both directions. Feel for binding or jamming in the steering gear mechanism.

(d) *Alignment.* [Toe-in and toe-out measurements shall not be greater than 1.5 times the value listed in the vehicle manufacturer's service specification for alignment setting.

Inspection procedure. Verify that toe-in or toe-out is not greater than 1.5 times the values listed in the vehicle manufacturer's service specifications for alignment settings as measured by a bar-type scuff gauge or other toe-in measuring device. Values to convert toe-in readings in inches to scuff gauge readings in ft/mi side-slip for different wheel sizes are provided in Table 2. Tire diameters used in computing scuff gauge readings are based on the average maximum tire dimensions of grown tires in service for typical wheel and tire assemblies. (39 F.R. 12867—April 9, 1974. Effective: 5/9/74)]

(e) *Power steering system.* The power steering system shall not have cracked or slipping belts, or insufficient fluid in the reservoir.

Inspection procedure. Examine fluid reservoir and pump belts for conditions indicated.

§ 570.8 Suspension systems.

(a) *Suspension condition.* Ball joint seals shall not be cut or cracked. Structural parts shall not be bent or damaged. Stabilizer bars shall be connected. Springs shall not be broken, or extended by spacers. Shock absorber mountings, shackles, and U-bolts shall be securely attached. Rubber bushings shall not be cracked, extruded out from or missing from suspension joints. Radius rods shall not be missing or damaged.

Inspection procedure. Examine front and rear end suspension parts for conditions indicated.

TABLE 2.—Toe-In Settings From Vehicle MFR's Service Specifications

Wheel Size (In)	Nominal Tire Diameter (In)	Readings In Feet Per Mile Sideslip								
		1/16"	1/8"	3/16"	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"
13	25.2	13.1	26.2	39.3	52.4	65.5	78.6	91.7	104.8	117.9
14	26.4	12.5	25.0	37.5	50.0	62.5	75.0	87.5	100.	112.5
15	28.5	11.5	23.0	34.5	46.0	57.5	69.0	80.5	92.0	103.5
16	35.6	9.3	18.6	27.9	37.2	46.5	55.8	65.1	74.4	83.7

[(39 F.R. 12867—April 9, 1974. Effective: 5/9/74)]

(b) *Shock absorber condition.* There shall be no oil on the shock absorber housing attributable to leakage by the seal, and the vehicle shall not continue free rocking motion for more than two cycles.

Inspection procedure. Examine shock absorbers for oil leaking from within, then with vehicle on a level surface, push down on one end of vehicle and release. Note number of cycles of free rocking motion. Repeat procedure at other end of vehicle.

§ 570.9 Tires.

(a) *Tread depth.* The tread on each tire shall be not less than two thirty-seconds of an inch deep.

Inspection procedure. Passenger car tires have tread depth indicators that become exposed when tread depth is less than two thirty-seconds of an inch. Inspect for indicators in any two adjacent major grooves at three locations spaced approximately equally around the outside of the tire. For vehicles other than passenger cars it may be necessary to measure tread depth with a tread gauge.

(b) *Type.* [Vehicle shall be equipped with tires on the same axle that are matched in tire size designation, construction, and profile.

Inspection procedure. Examine visually. A major mismatch in tire size designation, construction, and profile between tires on the same axle, or a major deviation from the size as recommended by the manufacturer (e.g. as indicated on the glove box placard on 1968 and later passenger cars) are causes for rejection. (39 F.R. 12867—April 9, 1974. Effective: 5/9/74)]

(c) *General condition.* Tires shall be free from chunking, bumps, knots, or bulges evidencing cord, ply, or tread separation from the casing or other adjacent materials.

(d) *Damage.* Tire cords or belting materials shall not be exposed, either to the naked eye or when cuts or abrasions on the tire are probed.

Inspection procedures. [Examine visually for conditions indicated, using a blunt instrument if necessary to probe cuts or abrasions. (39 F.R. 12867—April 9, 1974. Effective: 5/9/74)]

§ 570.10 Wheel assemblies.

(a) *Wheel integrity.* A tire rim, wheel disc, or spider shall have no visible cracks, elongated bolt holes or indication of repair by welding.

Inspection procedure. Examine visually for conditions indicated.

(b) *Deformation.* [The lateral and radial runout of each rim bead area shall not exceed one-eighth of an inch of total indicated runout.

Inspection procedure. Using a runout indicator gauge, and a suitable stand, measure lateral and radial runout of rim bead through one full wheel revolution and note runout in excess of one-eighth of an inch. (39 F.R. 12867—April 9, 1974. Effective: 5/9/74)]

(c) *Mounting.* All wheel nuts and bolts shall be in place and tight.

Inspection procedure. Check wheel retention for conditions indicated.

38 F.R. 23949
September 5, 1973

APPENDIX C

Recommended Uniform Inspection Guidelines

AMERICAN ASSOCIATION OF MOTOR VEHICLE ADMINISTRATORS
RECOMMENDED UNIFORM GUIDELINES
MOTOR VEHICLE SAFETY EQUIPMENT
INSPECTION ON A PERIODIC BASIS

I. Brake System Inspection

A. Component Brake Inspection (Wheel Removal):

1. *Wheel Bearings*-Trouble in this area will give audible warning. Seizure of bearings can mean impending loss of wheel or spindle;

2. *Caliper/Wheel Cylinder*-Broken or leaking cylinder is rare but must be repaired quickly, otherwise possible loss of braking/steering control may result; in addition, excessive cylinder leakage can cause extreme brake imbalance;

3. *Drum(s)/Rotor(s)*-Check for excessive wear beyond manufacturer's limits (cast or marked) on drum or disc. On drums, excessive wear can cause the pistons in the wheel cylinder to overextend resulting in a catastrophic failure. In both drums and discs excessive wear means loss of metal which has an adverse effect on fading (insufficient mass for heat absorption).

4. *Lining(s)/Disc Pad(s)*-Any lining or pad thickness will normally provide stopping capability. The minimal thickness check provides a guide as to how much longer they will last prior to replacement because of total wear.

5. *Lines and Fittings*-Check for wheel interference and for lines in unprotected location. Wrong tubing material (copper) is unacceptable when used as a brake line. Defects in lines/fittings will result in loss of braking through loss of fluid.

6. *Master Cylinder*-A cracked master cylinder is rare. Most importantly inspect for inadequate fluid level and leaking seals.

7. *Pedal Pressure*-This is difficult to measure, especially on power-assisted brakes.

8. *Brake Warning Light*-Check bulb for integrity of warning system and proper function.

9. *Power Booster*-New 'hydroboost" systems need fluid level check. Any "assist" system in danger of imminent failure could have "surprise effect" on operator.

10. P*arking Emergency Brake*-This system is necessary to supplement a failed service brake in addition to safe parking.

11. *Mechanical Parts*-Loose or broken pivots, return springs, shoes, etc., can be detected when wheel is removed.

B. Functional Brake Inspection: This inspection determines whether the braking system will stop the vehicle properly. It is a performance test and may be conducted in one of several ways in accordance with the desires and capabilities of the jurisdictions.

1. *Imbalance*-It is important to maintain straight-line stopping. Can use a platform tester or dynamic rollers; may, also, be checked on a road test.

2. *Stopping Capability*-Some consider a practical stopping demonstration to be the only true test of brake system. Road test or dynamic roller may be used.

II. Wheel System: Inspection of wheel and tire assembly is visual, essential to safety and easily done.

A. *Tires*-Cut or badly worn tires are quite critical to safety and are indicative of misalignment and other problems.

B. *Wheels*-Execessive run-out may indicate a bent or damaged wheel which is critical to safety. Condition of studs, nuts or mounting holes may also be critical but easily recognized.

III. Steering and Suspension System: These systems are very important to safety, but they are also the area of the vehicle most liable to exploitation by the "rip-off" artist since front-end geometry is difficult for the lay person to understand. Caster, Camber and Toe have been dropped from consideration because of the rarity with which they correlate to "unsafe" driving. Unsafe wheel alignment conditions are almost always determined by uneven tire wear.

A. *Ball Joints/King Pins*-Inspection must follow proper procedure. Ball joints are seldom dangerously worn unless they have no lubricant or have been hit and damaged. Beware of any diagnosis indicating that ball joints need replacement.

B. *Manual and/or Power Assist Mechanism*-The fluid level is important on the new "hydroboost" system connected with the power brake. Loose or frayed belts should be checked.

C. *Linkage*-Steering linkage is critical when it lacks lubricant or has been bent, or damaged. Can produce unpredictable steering variation.

D. *Stabilizers(when fitted)*-Looseness or poorly connected ends could cause trouble. Easy to check.

E. *Steering Wheel/Column*-Play should be measured. Sheared capsules on collapsible columns can be checked visually.

F. *Shock Absorbers*-Check for excessive leakage.

G. *Spring/Torsion Bars*-Check for breakage and proper anchorage respectively. Clues are often highly visible.

IV. **Fuel System**: The integrity of the fuel system is of obvious criticality to driving safety. Fuel should be properly contained.

A. *Storage*-The fuel tank should be well-fastened and should not leak. Filler cap should always be present and fastened.

B. *Supply*-Inspect for fuel leakage integrity. This will include the total supply system.

C. *Distribution*-From a safety standpoint, the carburator or fuel injector should be checked for leakage.

D. *Fire Suppression*-The carburetor, muffler and air cleaner assembly should be checked for proper precaution against "backfire suppression" since this is part of its function.

V. **Exhaust System**-Check entire exhaust system for leaks, damage, fastening, and general integrity. No part of system should run or leak into passenger compartment.

VI. **Lighting and Signal System**-Most inspections are based on the philosophy that if a light is there, it should function properly. The following list of "most important" items is indicated for inspection.

A. *Headlamps*-Check operation and aim.

B. *Hazard Warning Lamps*

C. *Stop Lamps*

D. *Tail Lamps*

E. *Turn Signal Lamps*

F. *License Plate Lamp(s)*

G. *Clearance/Side Market Lamps*

H. *Reflectors*

I. *Horn*

VII. **Visibility System**: Glazing, rear vision and devices to retain transparency are critical to driving safety. Inclement weather, even bright sunshine, are factors affecting driver visibility.

A. *Windshield*-Must be approved laminated safety glass. Labels and unapproved tinting material could affect vision.

B. *Side and Rear Windows*-Approved tempered glass is allowed. Opaque replacements can be dangerous.

C. *Rear View Mirrors*-Necessary to safety of driver and occupants of all vehicles in the vicinity.

D. *Defroster and Defogger*-Has obvious effect on visibility.

E. *Wiper and Washer*-These too have an obvious effect on driving safety and should function properly when required.

VIII. **Body Components**: These components are normally inspected for such things as proper closure; jagged edges caused by damage, and excessive corrosion allowing exhaust fumes to enter passenger compartment.

A. *Doors*-Should close properly for occupant retention and open properly for possible emergency exit.

B. *Floor Plan*-Holes caused by damage or corrosion can be a safety defect in that exahust fumes may enter the passenger compartment.

C. *Seats*-Can be dangerous if not properly attached.

D. *Front Hood Latch*-Can be dangerous if hood flies back, cutting off driver's vision.

E. *Safety Belts*-Should function properly and be adequately anchored. Deterioration of webbing can be critical.

F. *Bumpers*-Torn or jagged metal can be a hazard to pedestrians. Bumper should be present and properly fastened.

G. *Fenders*-Should be present to prevent road spray, and should not present jagged metal.

APPENDIX D

Description of Automated Inspection Procedures

In position one, the bus identification number is entered into the computer, along with other information, to track a specific vehicle through the tests. This information also allows the emissions test to be customized for each vehicle, since the pass-fail standards vary by model year, number of cylinders and so on.

Drive wheels are placed on a dynomometer to precondition the engine and simulate stresses and strains of actual driving conditions. To further precondition the engine and to clean out any pollutants which might have built up to give a false reading, the driver accelerates to a specified speed and keeps its there. The bar stays green while the speed is correct, and turns red if the inspector isn't keeping the speed where it should be.

When the preconditioning is finished, the bus drops back to idle and the tailpipe emission sampling begins. If emissions exceed the allowable limits programmed into the computer, the vehicle fails that part of the test.

While this test is going on, three other phases of the inspection process happen simultaneously. The inspector outside the bus conducts a visual inspection of the upper body items. If he finds failures, he enters a coded number which corresponds to the failed item.

The inspector driving the bus through the test lane does the inside visual inspection. Any failures are noted by a computer code number.

The third simultaneous inspection is a computer-controlled noise test, done while the bus is running at high speed on the dynomometer.

The TV monitors give the results of each test so far. The blue bar shows the standard the bus must meet. Green means the bus passes this particular test. A red display or a reading in the red zone means failure. TV monitors tell the driver to move on to the headlight alignment test. Meanwhile, the pass or fail data on this vehicle is stored in the computer record.

At the headlight tester, alignment and light intensity are measured. The test is conducted on both high and low beam on each side of the bus. By looking at the TV monitor and its graphic representation of the test results, the inspector or the vehicle owner can tell whether a headlight is aimed in the wrong direction and just what that wrong direction is, so corrective action can be taken. The computer also tells whether a headlight has become dim enough to need to be replaced.

The computer tells the driver to move on to position two. While the vehicle is moving to the next position, it drives over a plate imbedded in the lane floor. This is the computerized sideslip tester. In the few seconds it takes to roll over the plate, front end alignment is measured.

Next, the computer tells the inspector to get ready for the brake test. The computerized dynamic brake tester in position two customizes each brake test according to the distinct characteristics of each vehicle, and makes many types of determinations about how well the brakes work, such as rolling resistance, right or left imbalance, braking force and so on.

When the front wheel drops into the brake tester, the computer weighs the front axle. Then, after the rollers have turned for a few seconds, the computer measures the rolling resistance of each wheel.

Next, the TV monitors relay the computer's instructions to the driver to apply the brakes gradually, until the wheels apply their maximum braking force to the tester. All of the data is stored temporarily by the computer, while the rear wheels are put through the same procedure.

Finally, the computer tells the inspector to test the parking or emergency brake. Those results also are recorded and stored by the computer. When the brake tests are completed, the computer takes all the data and performs several calculations. It figures the total weight of the bus, the distribution of that weight over each axle, and how much braking force would be needed to stop the bus within recognized standards of performance.

The computer also determines whether each axle, individually, would have enough braking force to stop the bus if the other axles' brakes suddenly failed; and as a final measurement with the brake tester data, the computer uses the rolling resistance information to determine whether one of the wheels on the right or left side of the vehicle might be dragging enough to send the bus into a skid if the brakes were slammed on hard. All of this information is displayed in easy-to-read graphics on the TV monitors.

At position two, the visual inspection continues, focusing on the bus's warning lights and signals. With over a dozen marker lights, running lights, turn signal flashers, stop lights and semifour arm lights to check, the inspector's job is made much easier by strategically placing curved glass mirrors in the inspection lane. The inspector can see whether all the lights work, without leaving the driver's seat.

Ten minutes after the bus first enters the inspection lane it is ready to move to the third and final inspection position.

The bus straddles a pit in the center of the lane, so that the front end, chassis, undercarriage, exhaust piping, fuel tank, and fuel lines, can be visually checked for potential defects.

The bus wheels are positioned on a pair of shaker plates on either side of the inspection pit. Hydraulic cylinders under the plates are controlled by the inspector with a hand-held device. The plates can be moved individually or together, front to back or side to side, to simulate the stresses the vehicle's undercarriage and front end might encounter on the road.

The hand-held control has a high intensity light built into it so the inspector can get a close look at the darker recesses of the bus's underbody. This and the upperbody visual inspections are the only tests in the process where judgment calls have to be made. In the other tests the computer makes all of the pass-fail decisions, and eliminates the potential for human error or tampering.

If the position three inspector finds a failure, he enters the computer code for the failed item at the computer terminal in the pit. The bus is now clear to exit the lane, about fifteen minutes after it first started the inspection process.

Once all the data is in the computer, the final vehicle inspection report is printed out at the end of the test lane. The report includes date and time of the inspection, identifying information about the bus, and the results of each set of tests conducted at positions one, two and three. The computer then generates a pass-fail decision on the entire vehicle. The report includes valuable diagnostic information, which can help a mechanic save a great deal of time in finding and fixing any problems.

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